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Ecology of Marine Predatory and Prey Fishes off the Columbia River, 1998 and 1999

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Ecology of Marine Predatory and Prey Fishes off the Columbia River, 1998 and 1999

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EXECUTIVE SUMMARY

The National Marine Fisheries Service surface-trawled off the mouth of the Columbia River from April through July 1998 and 1999 to identify the pelagic fish community during the spring salmonid smolt migration period and to collect information on the feeding habits of predatory fishes. Preliminary results indicate that baitfish, primarily Pacific sardine (*Sardinops sagax*) and Pacific herring (*Clupea pallasi*), numerically dominate this nearshore community. Important fish predators, Pacific hake (*Merluccius productus*), jack mackerel (*Trachurus symmetricus*), and chub mackerel (*Scomber japonicus*), are at times abundant. Initial food-habit studies have not identified direct predation on salmonids. However, potential indirect effects of the changing pelagic fish community associated with different oceanographic regimes on juvenile salmonids are presented.

ACKNOWLEDGMENTS

Special thanks are due to Dan Parker, Captain of the FV *Sea Eagle*, for his willingness to work with us on these surveys. His encouragement and skill with fishing gear and equipment made this research possible. We also thank the crew of the FV *Sea Eagle*. Tim Hall and Ron Lowe made setting the trawl look easy and the cruises always interesting. Finally, thanks to Susan Hinton for providing logistical and moral support that enabled us to maintain intense ocean sampling schedules in 1998 and 1999.

INTRODUCTION

Ocean survival of salmonids from the Columbia and other Northwest rivers has declined markedly in the last 20 years (Hilborn and Coronado 1997, Coronado and Hilborn 1998), with some salmon returns less than necessary to maintain run sizes. To rebuild and maintain salmon runs, resource agencies have spent considerable funds ameliorating negative anthropogenic influences by restoring freshwater habitats, improving dam passage, releasing hatchery produced salmon, and other activities. However, these measures have met with limited success. There is increasing information that ocean survival plays a significant role in determining eventual adult salmon returns. Moreover, the Pacific Ocean off the Northwest appears to undergo cyclic "regime" shifts every 20–30 years, with contrasting environmental conditions resulting in contrasting favorability for salmonid production (Francis and Hare 1994, Mantua et al. 1997, Francis et al. 1998). In the present cycle, which began in 1977, ocean salmonid survival, and thus salmon populations, are high in Alaska but low in the Pacific Northwest (Hare et al. 1999). While salmonid ocean survival appears to be related to primary and secondary ocean production (Brodeur and Ware 1992, Polovina et al. 1995, Roemmich and McGowan 1995, Brodeur et al. 1996), the actual mechanisms controlling salmonid ocean survival are undetermined.

Research indicates that ocean survival of salmonids is evidently determined very early during their ocean residency, with predation thought to be a major influence (Fisher and Pearcy 1988; Pearcy 1988, 1992). Supporting this conclusion was Pearcy's (1988) discovery that average ocean purse-seine catches of coho salmon (*Oncorhynchus kisutch*) in June correlated closely with coho salmon jack counts (and thus adult run size) in the fall. This indicates that most ocean mortality often occurs during early ocean entry (April and May). Matthews et al. (1992) also found ocean survival for Columbia River spring/summer chinook salmon (*Oncorhynchus tshawytscha*) with early ocean entry in 1990 to be very poor, especially for hatchery fish.

While scientists have observed the declining ocean survival of Northwest salmonids, they have also noticed large numbers of marine fish predators becoming more abundant, arriving earlier, and staying longer in coastal waters, particularly Pacific hake, (*Merluccius productus),* chub mackerel (*Scomber japonicus),* and jack mackerel (*Trachurus symmetricus*). For example, in 1977, mackerel was rarely captured during the National Marine Fisheries Service (NMFS) triennial trawl surveys off Oregon; by 1995, mackerel was abundant and commonly caught at many stations (Mark Wilkins[1]). During a 6-year coastal purse-seine study off the Northwest, Brodeur and Pearcy (1986) identified a shift in the fish community during the 1983 El Niño, from a community dominated by forage fish and squid from 1979–1982 to one dominated by predators (chub mackerel, jack mackerel, and dogfish shark [*Squalus acanthias*]) in 1983. These piscivorous fishes may be a significant cause of juvenile salmon mortalities. For example, an investigation in British Columbia found that chub mackerel consumed nearly all the salmon smolts released from a nearby hatchery (Brent Hargreaves[2]), resulting in few returns from that brood-year release.

[1] Mark Wilkins; NMFS, 7600 Sandpoint Way NE, Seattle, WA 98115; pers. commun., March 1996.
[2] Brent Hargreaves, Canadian Fish and Oceans, Pacific Biological Station, Nanaimo, B.C. Canada V9R 5K6, pers. commun., March 1996.

Although feeding characteristics of common Pacific Northwest predatory fishes vary geographically, temporally, and with respect to life stage, the mitigating factors driving their feeding strategies are not known. For example, chub mackerel captured off Oregon in the early 1980s fed primarily on euphausiids (Brodeur et. al. 1987, Brodeur and Pearcy 1992). In California, however, it feeds primarily on larval and juvenile fishes and secondarily on squid and euphausiids (MBC Applied Environmental Sciences 1987). Food habit information from California indicates that chub mackerel are often a voracious feeder on fishes, particularly northern anchovy (*Engraulis mordax*). A preliminary examination of chub mackerel feeding habits off Vancouver Island, British Columbia in 1984 revealed that salmonids were eaten, although Pacific herring (*Clupea pallasi*) was the primary prey (Ashton et al. 1985). Juvenile jack mackerel has been found to feed heavily on market squid (*Loligo opalescens*) and northern anchovy, whereas the adult eats fishes (lantern fishes and northern anchovy), squid, pelagic crustaceans (euphausiids and copepods), and pteropods (MBC 1987).

Another example of a predatory fish with a varying diet is Pacific hake. Hake make broad migrations from their winter spawning grounds off southern California to their summer feeding ground off Oregon, Washington, and British Columbia. In the fall they migrate south to California. While hake are are found at the shelf break during spring, by summer many hake can be found on the shelf at depths <100 m. Pacific hake also make diurnal migrations, moving from near the bottom during the day to near the surface at night (Bailey et al. 1982). Hake feeds primarily on euphausiids, shrimp, and fishes, with fishes (primarily northern anchovy off Oregon) being more important to larger individuals (Livingston and Alton 1982). In 1980, 70% of the diet of larger hake (>55 cm total length) off Oregon-Washington was composed of fish (Bailey et al. 1982). The extent of predation by these fishes on juvenile salmonids is unknown, but given the temporal, geographic, and size-related variation in their feeding habits, their potential impact could be extensive.

Because of their large population size, Pacific hake could impact juvenile salmon populations even if hake diets includes a low percentage of salmonids. The Pacific hake population represents the largest single-species fishery (biomass) on the West Coast. Approximately 3 billion Pacific hake were expected to migrate into Northwest waters during the spring/summer of 1997 (Dorn 1996), the biological demand of this population will undoubtedly have a large impact on coastal marine food webs and biological communities in Northwestern coastal waters (Ware and McFarlane 1995). Research off British Columbia indicates that recent increases in numbers of Pacific hake and mackerel in these waters have increased the predation rates on and decreased the abundance of Pacific herring (Ware and McFarlane 1995). We hypothesize that the timing of movement, food habits, and abundance of these seasonal migrant marine fish predators into Oregon and Washington coastal waters has a significant effect on the biological community on which juvenile salmonid ocean survival is dependent. We further hypothesize that the distribution and abundance of the nearshore marine-predator and forage-fish community affects the amount of predation on juvenile salmonids by marine predatory fish.

There are no detailed or recent data on the feeding habits of piscivorous fishes off the mouth of the Columbia River during the salmonid smolt outmigration period (spring). By assessing the dynamics of the marine-fish predators and forage-fish communities during this period, and by monitoring the food habits of the dominant marine fish predators (by analyzing stomach contents), we will determine whether predation is a large direct or indirect source of marine mortality of juvenile salmonids entering the ocean from the Columbia River. We will

also identify how this predation is mediated by alternative prey abundance (abundance of northern anchovy, or sardines [*Sardinops sagax*], from this and an ongoing NMFS study) and physical oceanographic conditions (temperatures, salinities, etc.).

This research has five overall objectives:

1) In 1998, to determine the best method to capture large pelagic marine fish that may prey on juvenile salmonids.
2) Identify the temporal dynamics and abundance of marine-fish predators and forage fishes in the nearshore ocean off the Columbia River during the juvenile salmon outmigration period.
3) Identify the food habits of predatory marine fishes off the Columbia River.
4) Identify oceanographic conditions (ocean temperatures and salinities) in the nearshore ocean off the Columbia River during the spring and early summer.
5) Relate predator and forage fish distribution and abundance to oceanographic conditions and ocean survival of juvenile salmonids.

METHODS

Large marine-fish predators (primarily Pacific hake, chub mackerel, and jack mackerel) and other associated fishes (Pacific herring, northern anchovy, Pacific sardine, etc.) and squid were collected by surface trawling, primarily during nighttime but also during daylight (evening and morning), with a commercial mid-water trawler. Nighttime samples were collected because many fishes (particularly Pacific hake) migrate from depth to the surface at night (diel vertical migration) (Bailey et al. 1982). In 1998, a variety of trawls were utilized in our attempt to identify an appropriate gear type that would effectively sample the near-surface environment for small and large fishes. We eventually selected a 264-rope trawl with 3-m foam-filled Lite doors, designed and built by Net Systems[3], as the most effective gear type. This is the same gear that the NMFS Alaska Fisheries Science Center is using to capture juvenile salmonids and associated fishes off southeast Alaska (Murphy et al. 1999). It is also used by the NMFS Southwest Fisheries Science Center in California conducting a similar study. In 1999, all samplings were conducted using the 264-rope trawl. The trawl is 100-m long with a mouth area approximately 30-m wide and 20-m deep. Mesh size ranges from 126.2 cm in the throat of the net near the jib lines to 8.9 cm in the cod end. A 6.1-m long, 0.8-cm stretch knotless web liner was sewn into the cod end to effectively capture anchovy and other baitfish.

The 264-rope trawl was fished by towing it 183 m (100 fathoms) behind the vessel, an 85-ft chartered commercial fishing trawler, travelling approximately 4 knots (7.4 km/hour) for 30 minutes. In 1998, other trawls were fished (Table 1) at a variety of speeds and distances behind the vessel, but these were abandoned when it became apparent that the 264-rope trawl and Lite doors worked most effectively: the 264-rope trawl was easy to deploy and retrieve, was obviously fishing at the service (head floats were visible), and was effective at catching all sizes of fish. Furthermore, because this gear is also being used in other studies along the entire West Coast, we will be able to directly compare our catch data with these studies data.

[3] Mention of trade names does not mean endorsement by NOAA, NMFS, or Department of Commerce.

Table 1. Type and size of fishing gear used to collect fish off the Columbia River in 1998 and 1999.

Trawl net	Trawl door	Net mouth width (m)	Net mouth height (m)
commercial hake trawl	5-m thyborϕn	56	28
rock-hopper	5-m thyborϕn	20	16
rock-hopper	3-m suber krube	20	16
#4 rope trawl	5-m thyborϕn	30	20
#4 rope trawl	3-m suber krube	30	20
264 rope trawl	3-m foam filled	30	20

In 1998, we followed a general tract line that started off Willapa Bay, traveled west for about 30 nautical miles, turned south across the Astoria Canyon, and finally turned east toward shore, just below the mouth of the Columbia River (Fig. 1). Along this general tract line we attempted to capture as many predatory fishes as possible. To do this with untested gear, we focused our sampling where significant targets (i.e., fish schools) were observed to be near the surface on the depth sounder. The purpose of setting on targets, instead of specific locations, was to verify that the gear type we were using could actually fish at the surface and capture fishes effectively. Identifying the most appropriate sampling gear was one of our primary objectives in 1998.

In 1999, we sampled at pre-determined stations along two transect lines north and south of the entrance to the Columbia River (Fig. 1). Six stations were sampled along each transect, with the first station being as close to shore as possible but at least 30-m deep, and the farthest stations approximately 30 km from shore. Sampling at predetermined stations, instead of on identified schools, enables us to calculate unbiased estimates of predator and prey abundance within the study area during the survey period.

Sampling was conducted approximately every 2 weeks from April 16 to August 10 in 1998, and approximately every 10 days from April 13 to July 27 in 1999, for a total of 20 sampling days (10 sampling cruises/year). Sampling effort was focused on spring because salmonid ocean survival (particularly for coho salmon) is hypothesized to be determined at that time (Pearcy 1992). Furthermore, this is the period when a large number of juvenile salmonids are entering the ocean and thus when predator/prey interactions are most likely to be observed.

From each trawl, all potential salmonid predators and forage fish species were identified, enumerated, and measured, except when large catches occurred. With large catches, a random sample of 30 individual fish from each species was measured and the rest counted. During each cruise, a subsample (20 specimens) of each predatory species was iced, transported to the laboratory, and measured and weighed to determine accurate length/weight relationships. From each trawl, up to 30 stomachs of each potential marine fish predator species were removed and preserved in a 10% formalin solution. A stratified sampling design was used to screen a large number of predator stomach contents for juvenile salmonids. In detail, we took stomachs from the first 30 fish of a species from a trawl and then quickly checked all other stomachs for the presence of salmonids. When large catches of predators occurred, a subsample (30) stomachs were preserved for detailed laboratory analysis and the rest were visually inspected on deck. The visual inspection was conducted by cutting open predators, inspecting the stomach contents, recording general content (euphausiids, etc.), and saving the stomach (preserving in formalin) if there were indications of juvenile salmonid (or unidentified fish) remains. In a couple of circumstances where extremely large catches of predators did not allow inspection of all stomachs from all fish collected, we examined as many stomachs as time allowed. Detailed stomach analysis is being conducted and will be presented in a later report. Physical oceanographic data (temperature and salinity) profiles were collected at all trawl stations by lowering a SeaBird SB-19 conductivity, temperature, and depth (CTD) probe to 50-m depth.

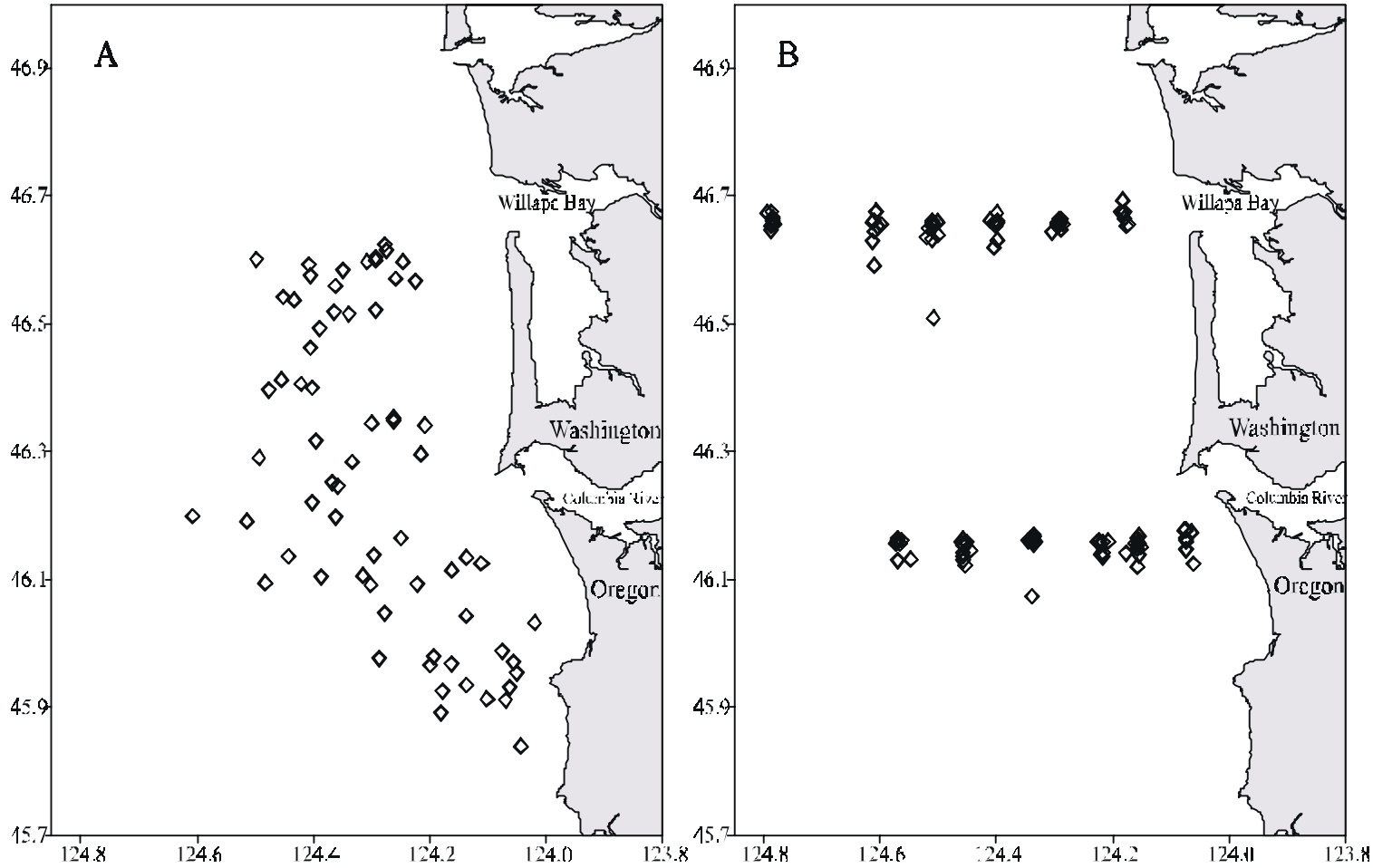


Figure 1. The location of surface trawls conducted in 1998 (A, 72 trawls), and 1999 (B, 113 trawls) to collect predatory fishes of juvenile salmon and associated species. In 1999, stations were located along two transects.

RESULTS

We conducted 72 and 113 trawls in 1998 and 1999, respectively (Appendix 1). However, during 1998 we spent many cruises trying out different gear configurations, and many of these initial trawl efforts were not effective surface trawls (i.e., we could not get the net to fish at the surface). Starting June 27, 1998, we began using the 264-rope trawl and continued using this gear through 1999.

Collections of fish and squid totaled 41,304 in 1998 and 27,762 in 1999 (Table 2). We captured many more Pacific hake in 1998 (13,478) than in 1999 (2,274), probably because we were setting gear on sonar observable fish schools in 1998, some trawls were at depth, and initially we sampled with a large hake net. The dominant fish species captured was Pacific herring (13,518) in 1998 and Pacific sardine (10,455) in 1999.

Overall, forage nekton (Pacific herring, Pacific sardine, market squid, northern anchovy, and smelt) comprised most of the catches (Tables 2 and 3). Highest catches occurred during the July 12–14, 1998 cruise, when over 18,000 fish (Table 3) (mostly Pacific herring and Pacific sardine) were captured. Lowest catches occurred during the second cruise of 1999, from April 22–24, when only 114 fish were captured. The second lowest catch took place during May 27–29, 1999 when only 123 fish were captured.

During the 2 years of this study, 4,491 stomachs were either examined qualitatively or retained for later quantitative examination (Table 4). Most stomachs were from Pacific hake, with 2,809 collected in 1998 and 458 in 1999. In 1998, most hake stomachs were empty, and almost half were empty in 1999 (Table 4). In 1998, one juvenile salmon was identified from one hake stomach, but its fresh condition indicated net feeding (Table 5). Both mackerel species were found to be feeding primarily on a variety of pelagic invertebrates (e.g., copepods or euphausiids) (Table 5). We are undertaking quantitative examination of the collected stomachs.

The Pacific hake captured in 1998 were slightly larger on average than those captured in 1999, with mean standard lengths of 395 mm SL and 387 mm SL, respectively (Fig. 2). Chub mackerel were slightly smaller in 1998 than in 1999, 297 mm FL (fork length) and 317 mm FL, respectively (Fig. 3). While jack mackerel overall average size was slightly larger in 1999 (396.0 mm FL vs. 385.0 mm FL in 1998) its length distribution appeared to be bi-modal (Fig. 4). This was particularly evident in 1999, where two size-groups were obvious, one that ranged from 310 mm FL to 430 mm FL, and a larger group that ranged from 440 mm FL to 590 mm FL.

Northern anchovy showed one size-mode, with a mean of 137.3-mm FL. Pacific sardine showed a broad length distribution, from 110 mm to 300 mm FL (Fig. 5). However, most sardine ranged from 180 mm to 280 mm FL, with a small mode centered around 200 mm FL and another around 240 mm FL. Pacific herring also had a very broad size range, from 60-mm FL to 280-mm FL (Fig. 6). However, most Pacific herring ranged from 120 mm to 250 mm FL. Overall, Pacific herring averaged 188 mm FL (Fig. 6), which is about half way between the mean lengths of northern anchovy (137 mm FL) and Pacific sardine (229.5 mm FL).

Table 2. Total number of nekton captured during predation cruises in 1998 and 1999 off the mouth of the Columbia River.

Common Name	Scientific Name	1998 Number captured	1999 Number captured
California market squid	*Loligo opalescens*	207	1,482
Lamprey	Petromyzontidae	7	
River lamprey	*Lampetra ayresii*		1
Pacific lamprey	*Lampetra tridentata*	1	4
Shark	Chondrichthyes	3	
Thresher shark	*Alopias vulpinus*		2
Soupfin shark	*Galeorhinus zyopterus*	4	6
Blue shark	*Prionace glauca*	4	5
Spiny dogfish	Squalus acanthias	90	129
Skates	Rajidae	1	1
Big skate	*Raja binoculata*		13
Spotted ratfish	*Hydrolagus colliei*	1	
Unidentified bony fish	Osteichthyes		6
American shad	*Alosa sapidissima*	49	207
Pacific herring	*Clupea pallasi*	13,518	6,031
Pacific sardine	*Sardinops sagax*	8,875	10,455
Northern anchovy	*Engraulis mordax*	1,593	1,557
Chum salmon juvenile	*Oncorhynchus keta*		1
Coho salmon adult	*Oncorhynchus kisutch*	12	1
Coho salmon juvenile	*Oncorhynchus kisutch*	6	36
Chinook salmon <=1 yr.	*Oncorhynchus tshawytscha*	25	395
Chinook salmon >1 yr.	*Oncorhynchus tshawytscha*	68	11
Chinook salmon adult	*Oncorhynchus tshawytscha*	8	21
Steelhead	*Oncorhynchus mykiss*		1
Smelts	Osmeridae	59	100
Surf smelt	*Hypomesus pretiosus*		12
Night smelt	*Spirinchus starksi*		4
Longfin smelt	*Spirinchus thaleichthys*		62
Eulachon	*Thaleichthys pacificus*		35
Whitebait smelt	*Allosmerus elongatus*	1,339	840
Longfin dragonfish	*Tactostoma macropus*	6	
Lantern fish	Myctophidae	497	
Plainfin midshipman	*Porichthys notatus*		29

Table 2. Total number of nekton captured during predation cruises in 1998 and 1999 off the mouth of the Columbia River. Continued.

Common Name	Scientific Name	1998 Number captured	1999 Number captured
Pacific tomcod	*Microgadus proximus*	1	996
Pacific hake	*Merluccius productus*	13,477	2,259
Rockfishes	*Sebastes* spp.		15
Yellowtail rockfish	*Sebastes flavidus*	2	1
Black rockfish	*Sebastes melanops*	19	42
Sablefish	*Anoplopoma fimbria*		3
Pacific staghorn sculpin	*Leptocottus armatus*		5
Snailfish	Cyclopteridae	1	1
Jack mackerel	*Trachurus symmetricus*	289	1,947
Pacific pomfret	*Brama japonica*	21	
Pacific sandfish	*Trichodon trichodon*	2	
Wolf-eel	*Anarrhichthys ocellatus*		11
Ragfish	*Icosteus aenigmaticus*	1	1
Pacific sand lance	*Ammodytes hexapterus*		4
Chub mackerel	Scomber japonicus	712	622
Pacific sanddab	*Citharichthys sordidus*	370	239
Slender sole	*Eopsetta exilis*		3
Rex sole	*Errex zachirus*	1	2
Dover sole	*Microstomus pacificus*	5	
Starry flounder	*Platichthys stellatus*		130
Butter sole	*Pleuronectes isolepis*		9
English sole	*Pleuronectes vetulus*	22	8
Sand sole	*Psettichthys melanostictus*		1
Total		41,296	27,746

Table 3. Number of baitfish (Pacific sardine [*Sardinops sagax*], northern anchovy [*Engraulis mordax*], Pacific herring [*Clupea pallasi*], and smelt), predators (Pacific hake [*Merluccius productus*], chub mackerel [*Scomber japonicus*], jack mackerel [*Trachurus symmetricus*], and sharks), and other fishes captured during pelagic trawling surveys off the mouth of the Columbia River in 1998 and 1999. Cruises do not represent equal effort due to varying gear type and number and length of tows (see Appendix 1).

Cruise number	Start date	Number of hauls	Baitfish	Predators	Other	Total Caught
1	16-Apr-98	10	34	219	62	315
2	30-Apr-98	4	31	328	10	369
3	15-May-98	6	175	134	254	563
4	31-May-98	8	1,247	3,428	39	4,714
5	12-Jun-98	6	628	540	77	1,245
6	27-Jun-98	9	1446	2,459	28	3,933
7	12-Jul-98	9	15,390	2,637	85	18,112
8	27-Jul-98	11	5,020	2,376	695	8,091
9	10-Aug-98	9	1,413	2,447	94	3,954
1998 Total		72	25,384	14,568	1,344	41,296
1	13-Apr-99	10	372	10	91	473
2	22-Apr-99	11	36	23	55	114
3	04-May-99	12	6,047	106	670	6,823
4	13-May-99	11	248	989	802	2,039
5	27-May-99	11	39	59	25	123
6	12-Jun-99	12	241	834	89	1,164
7	25-Jun-99	12	676	833	94	1,603
8	06-Jul-99	12	778	358	432	1,568
9	13-Jul-99	10	722	287	1,294	2,303
10	27-Jul-99	12	9,937	1,458	141	11,536
1999 Total		113	19,096	4,957	3,693	27,746

Table 4. Number of predatory fish stomachs taken quantitatively and examined qualitatively to estimate predation of juvenile salmonids off the mouth of the Columbia River, 1998 and 1999.

Predator name	Year	Taken for quantitative examination	Examined onboard qualitatively	Total
Jack mackerel	1998	27	110	137
(*Trachurus symmetricus*)	1999	163	383	546
Pacific hake	1998	830	1,979	2,809
(*Merluccius productus*)	1999	245	217	462
Chub mackerel	1998	205	103	308
(*Scomber japonicus*)	1999	75	81	156
Spiny dogfish	1998	26	11	37
(*Squalus acanthias*)	1999	10	25	35
Other shark species	1998		1	1
Total		1,581	2,910	4,491

Table 5. Results of onboard qualitative examinations of 2,910 predator stomachs collected off the mouth of the Columbia River, 1998 and 1999. Some predators had more than one prey type in their stomachs.

	Qualitative exam onboard – Number of stomachs containing											
Predator name Year	Empty	Invertebrates/ euphausiids	Unidentified fish	Northern anchovy	Pacific herring	Pacific sardine	Flatfish	Smelt	Lantern fish	Salmon	Snailfish	Digested material
Jack mackerel *(Trachurus symmetricus)*												
1998	99	11										
1999	215	157					1		1			10
Pacific hake (*Merluccius productus*)												
1998	1,531	434	3	7		1		1		1		
1999	96	121	2				1	2				
Chub mackerel (*Scomber japonicus*)												
1998	58	45										
1999	25	54										2
Spiny dogfish (*Squalus acanthias*)												
1998	9		2									
1999	12	2	10	1							1	
Other shark species												
1998	0			1	1							
Total	2,045	824	17	9	1	1	2	3	1	1	1	12

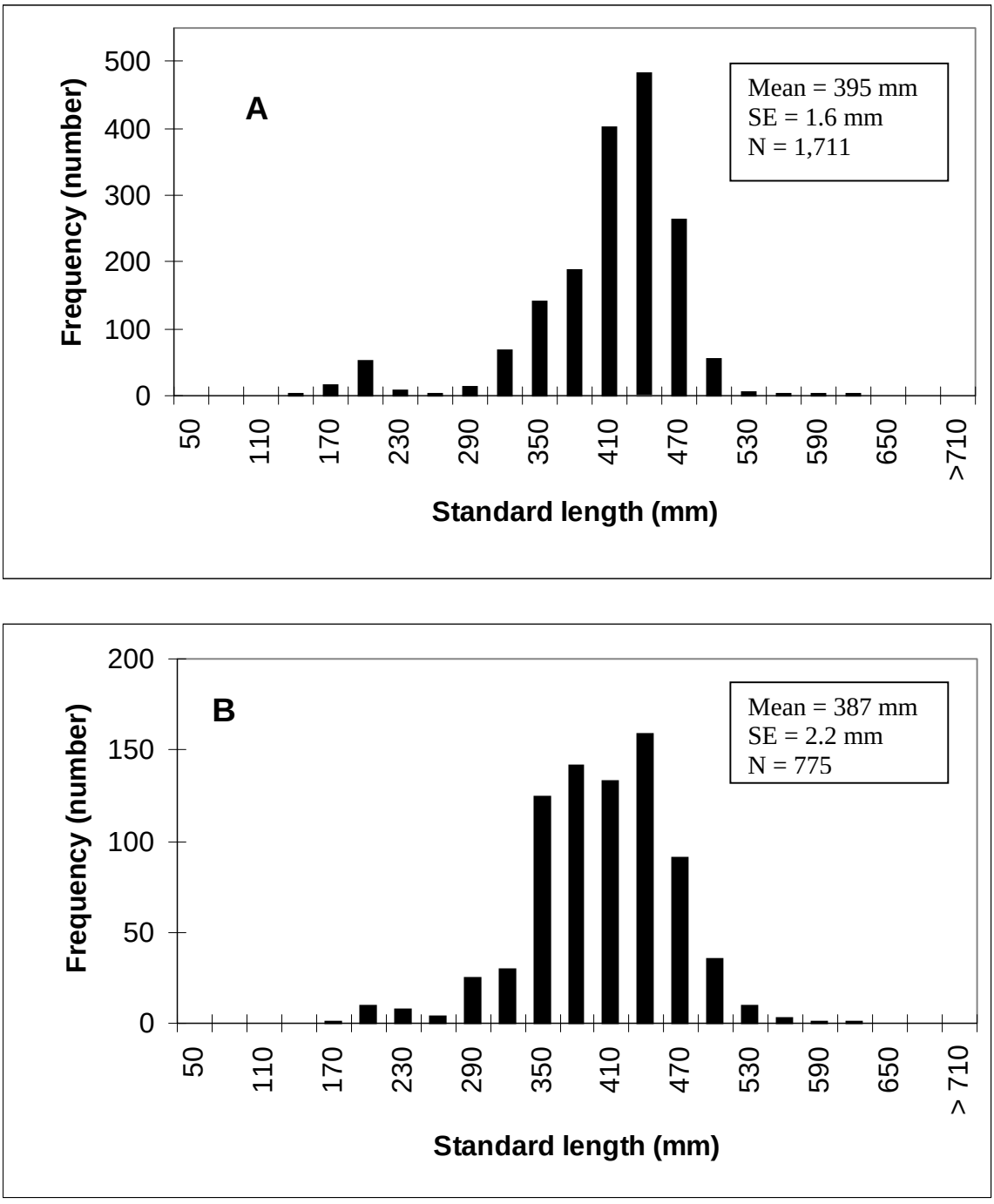


Figure 2. Length frequency distribution of Pacific hake (*Merluccius productus*) captured off the mouth of the Columbia River by surface trawl in 1998 (A) and 1999 (B).

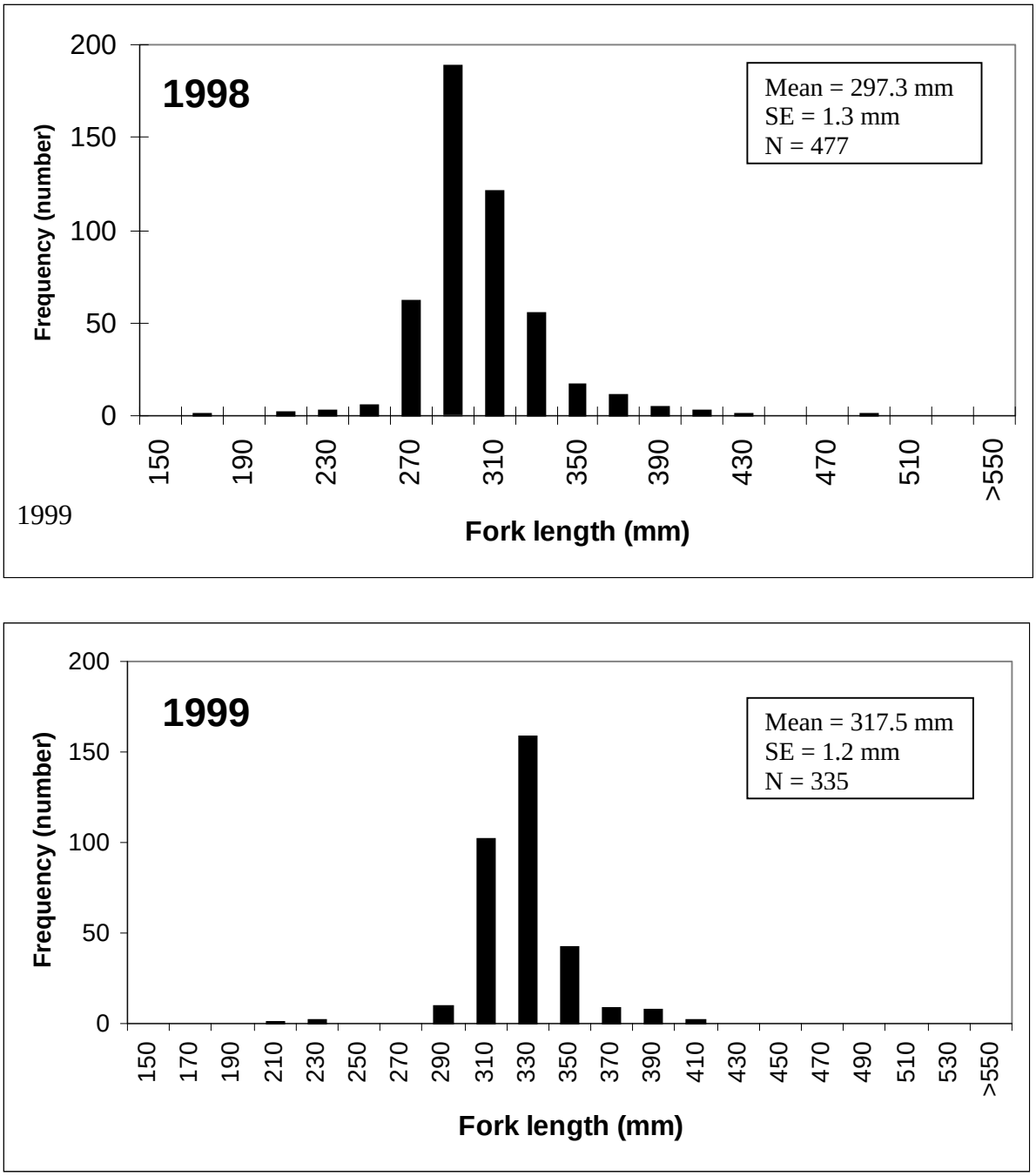
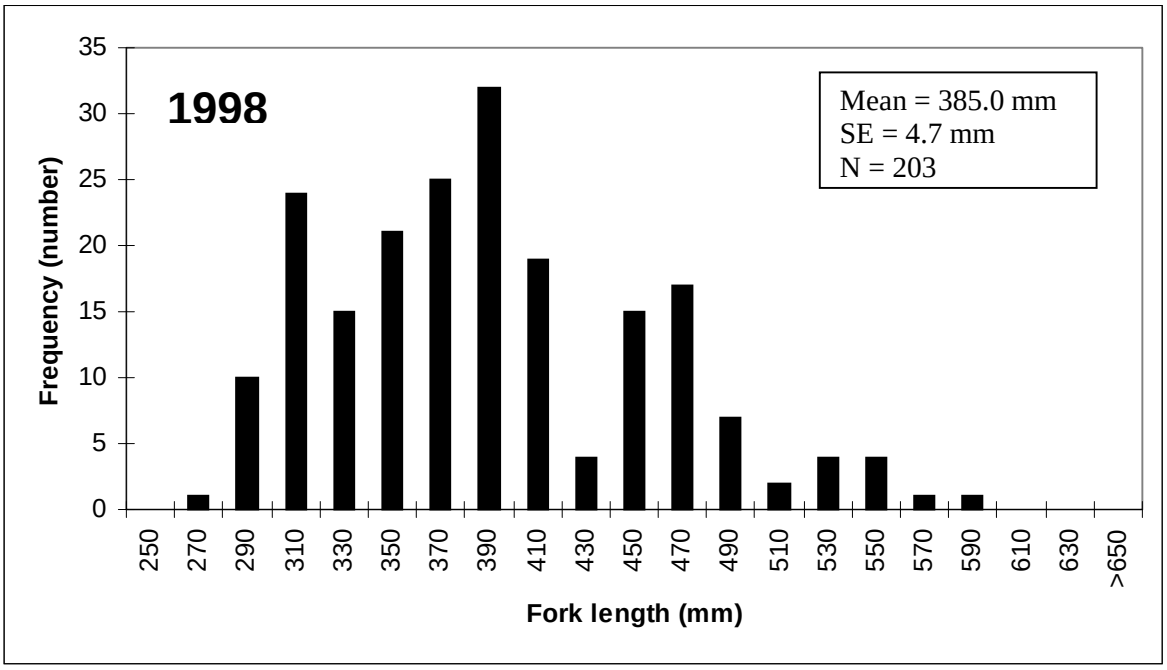


Figure 3. Length frequency distribution of chub mackerel (*Scomber japonicus*) captured off the mouth of the Columbia River by surface trawl, 1998 and 1999.



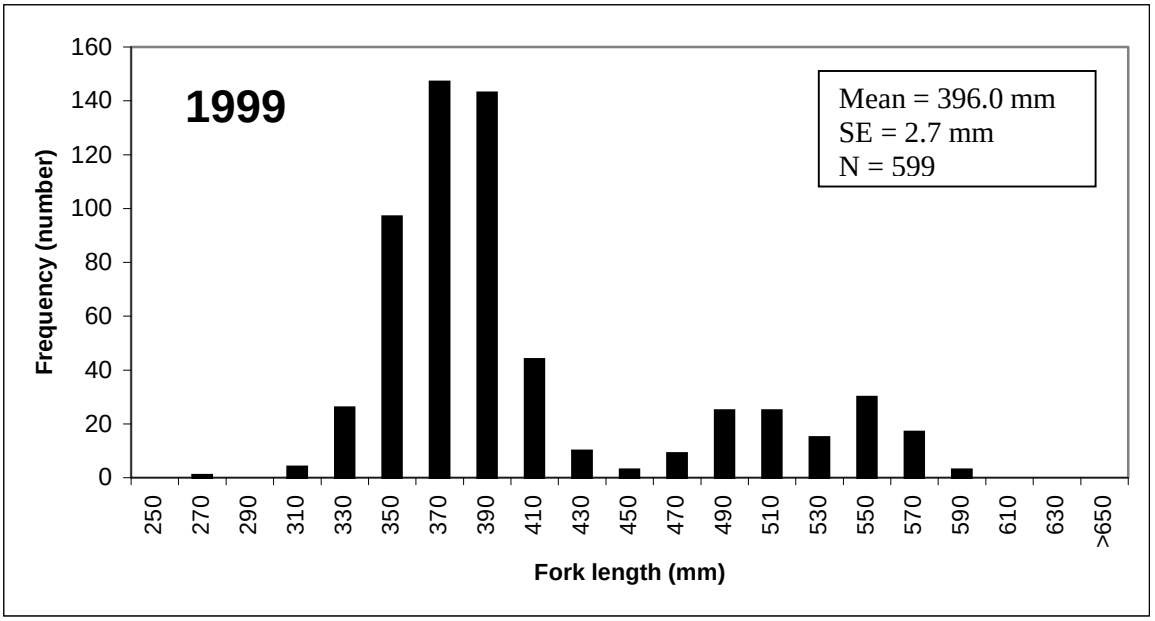


Figure 4. Length frequency distribution of jack mackerel (*Trachurus symmetricus*) captured off the mouth of the Columbia River by surface trawl, 1998 and 1999.

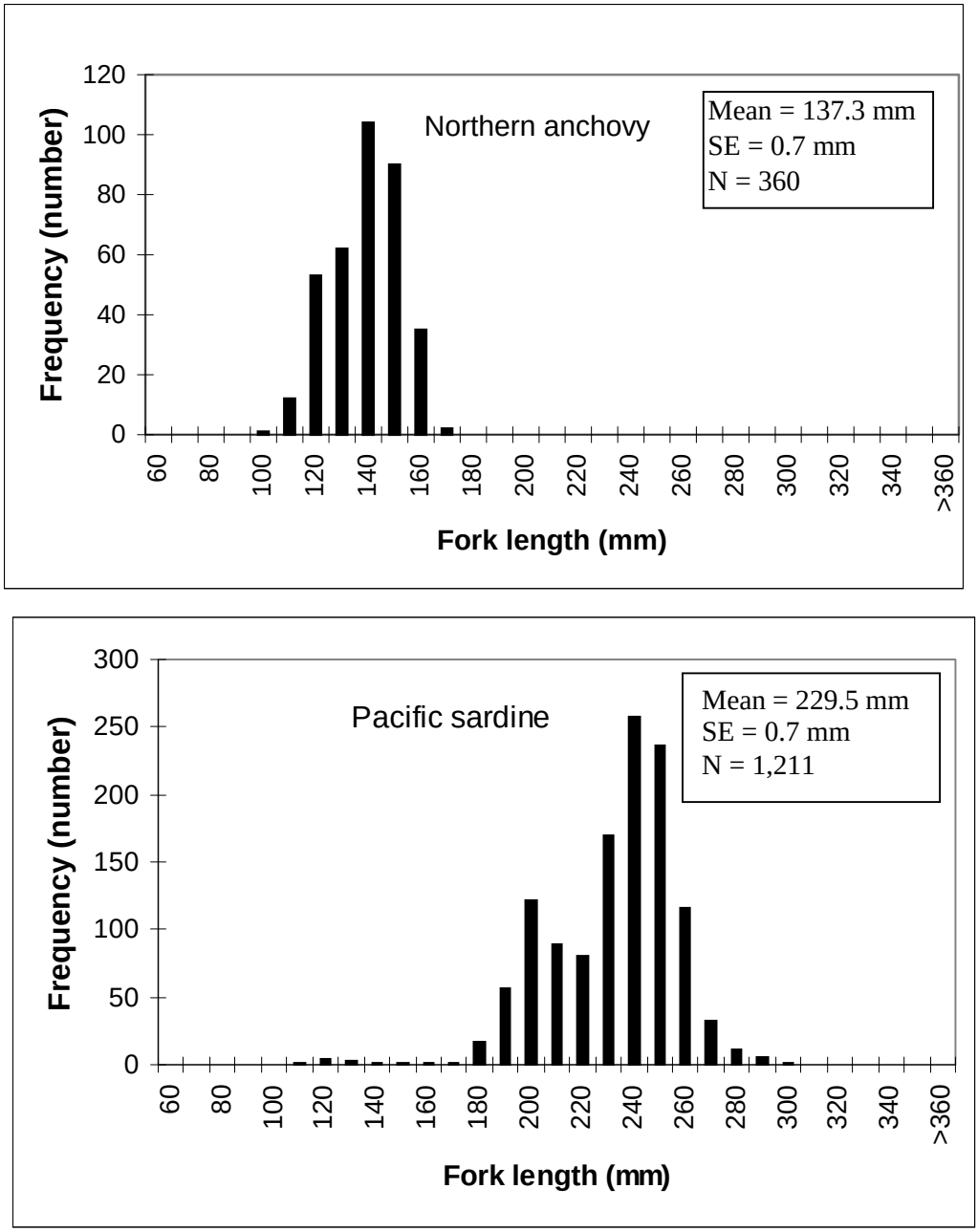
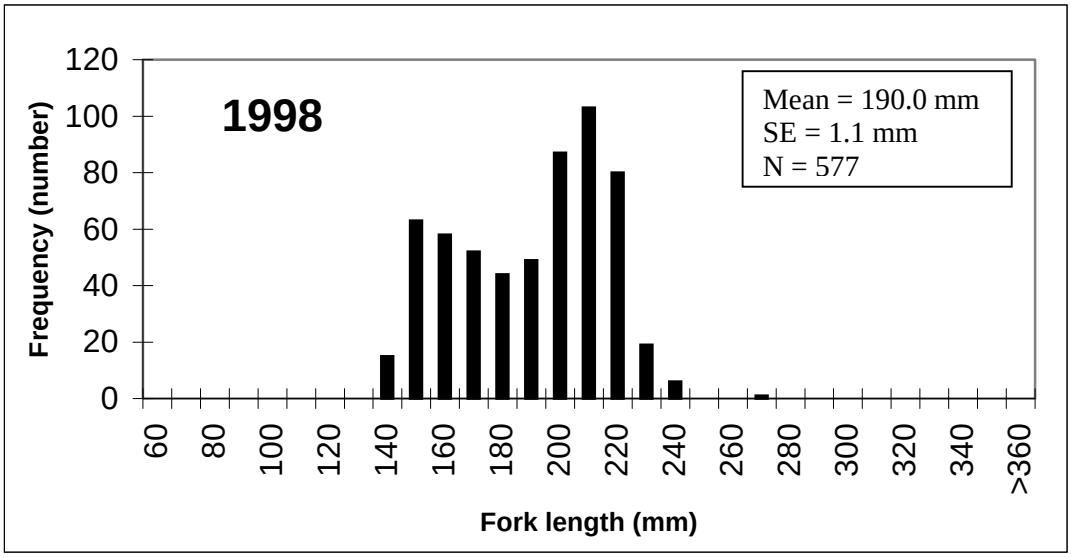


Figure 5. Length frequency of northern anchovy (*Engraulis mordax*) and Pacific sardine *(Sardinops sagax*) collected off the Columbia River by surface trawl, during April through July 1998 and 1999. Both years combined.



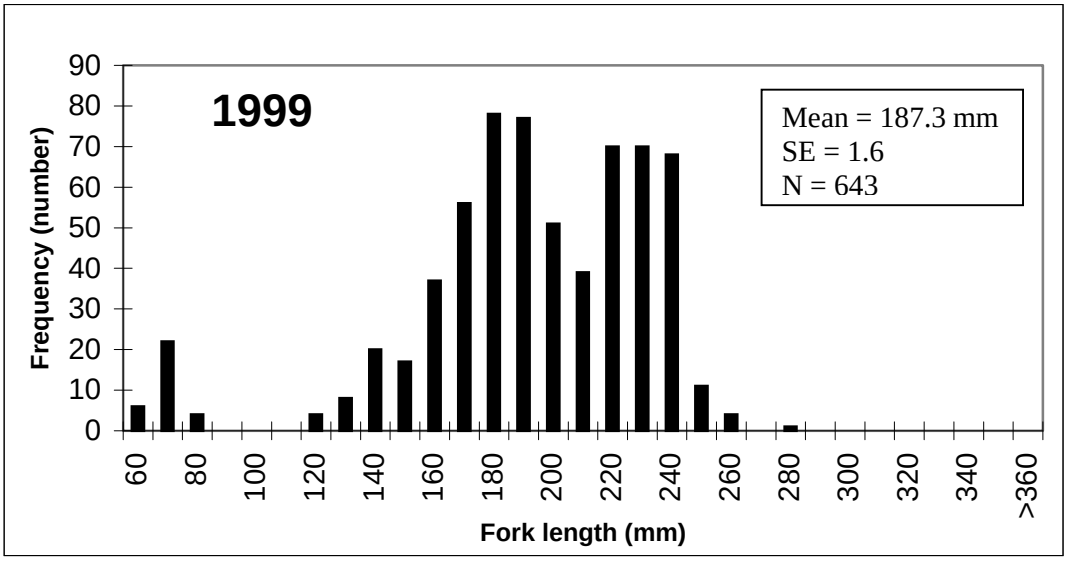


Figure 6. Length frequency of Pacific herring (*Clupea pallasi*) collected off the Columbia River by surface trawl, during 1998 and 1999.

Overall, sea-surface salinities were relatively similar between years (Fig. 7). However, sea-surface temperatures were on average 1.4°C cooler (SE = 0.5, $P < 0.05$) in 1999. The dip in sea-surface salinities during Cruises 3, 4, and 5, was probably due to increased runoff from the Columbia River plume in spring. Lowest overall sea-surface temperature observed was 9.0°C at Willapa Bay Stations 5 and 9 during the first survey of 1999 (Table 6). Highest overall sea-surface temperature observed was 17.8°C off the mouth of the Columbia River, July 29, 1998. Lowest surface salinity, 15.5 ppt, was observed on May 15, 1999 at Station 10 on the Columbia River transect.

The 1999 CTD data provided a better overall view of salinity and temperature profiles during each cruise because the data were collected on track lines perpendicular from shore. Appendix 2 shows profiles of temperature and salinity by depth and distance offshore during 1999. These temperature profiles reveal that by April 22, 1999, cold (9°C), nutrient-rich water was within 20 m of the surface, probably indicating the beginning of upwelling conditions. By May 27, 1999, 8°C water was within 20 m of the surface, and by June 12, 1999 upwelling was strong, with surface temperatures showing a sharp horizontal gradient.

The 1999 salinity information showed the location of the Columbia River plume. During the first 1999 cruise, from April 13–15, the plume appeared to be moving offshore and south (Appendix 2) with a little fresh water moving north. Some fresh water appeared to move north during early May, but by late May (Cruise 5), the plume appeared to turn sharply south. Under this condition, no low salinities were found on the Willapa Bay transect, and very low salinities (plume) were found at nearshore stations along the Columbia River transect (7, 10, and 15 nautical miles from the coast) (Appendix 2). Interestingly, low salinities (<32 ppt) occurred primarily above 10 m, except for the first cruise of 1999 (April 13–15).

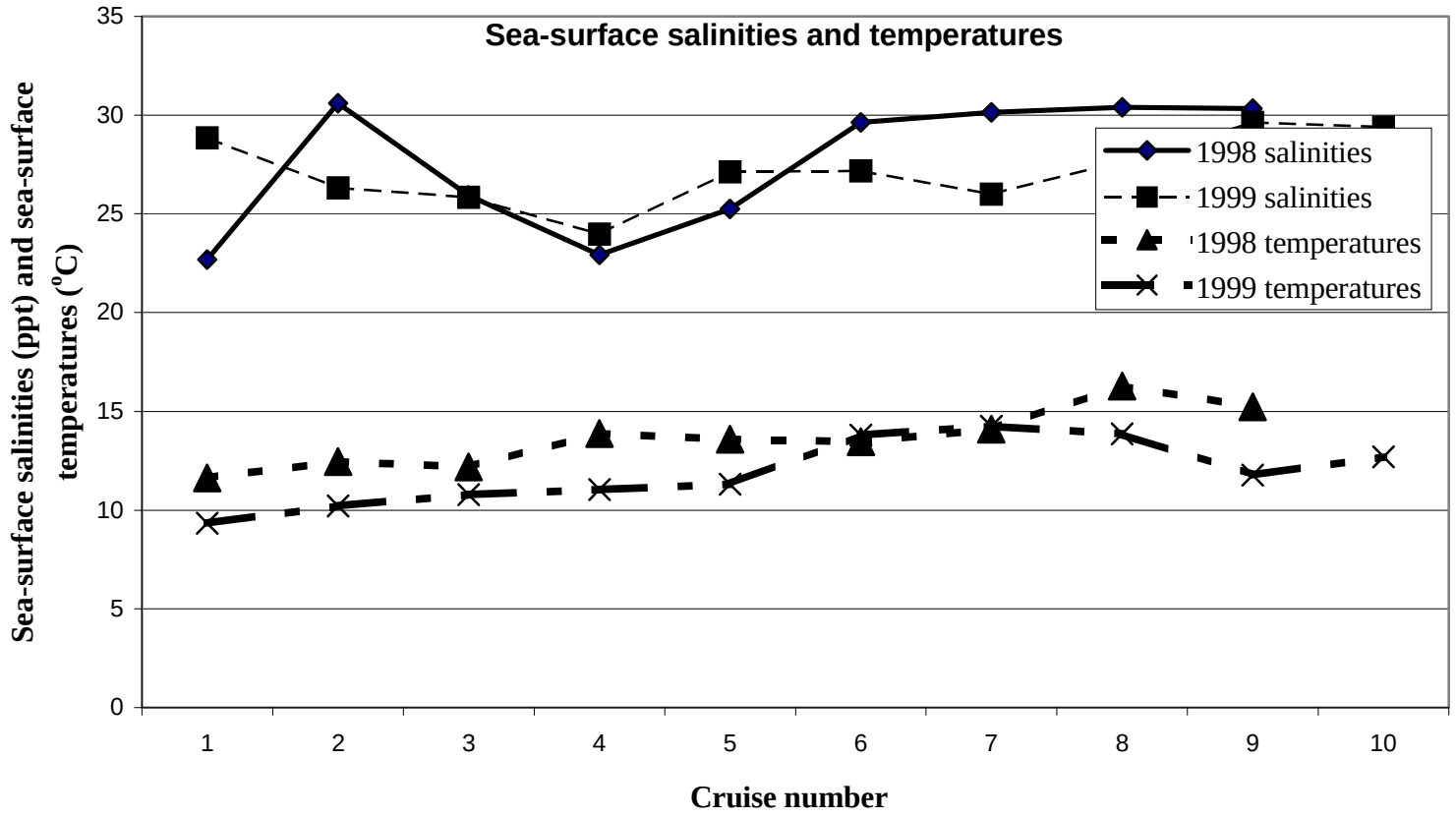


Figure 7. Average sea-surface salinities and temperatures at surface trawl stations during sampling cruises in 1998 and 1999.

Table 6. Near-surface (1-m depth) salinity and temper+ature along two transect lines off the Columbia River mouth, April–July 1999. Dashes indicate missing data.

		Willapa Bay stations (approximate distance [nautical miles] from shore)											
		5		9		14		19		23		30	
		Temp.	Salin.	Temp.	Salin.	Temp.	Salin.	Temp.	Salin.	Temp.	Salin.	Temp.	Salin.
Cruise	Date	(°C)	(‰)	(°C)	(‰)	(°C)	(‰)	(°C)	(‰)	(°C)	(‰)	(°C)	(‰)
1	13-15 April	9.0	30.90	9.0	30.23	9.3	29.06	9.4	29.79	9.3	30.69	9.2	30.92
2	22-24 April	--	--	10.2	25.93	10.2	27.30	9.8	30.19	9.7	30.09	9.7	32.11
3	4-6 May	11.1	22.34	10.9	24.56	9.9	30.63	9.8	31.34	9.8	31.54	10.2	31.97
4	13-15 May	--	--	11.6	19.05	11.5	22.10	11.3	24.77	9.9	28.99	10.3	31.51
5	27-29 May	--	--	10.1	29.62	11.4	27.68	12.0	28.36	12.2	27.75	12.3	29.06
6	12-14 June	13.8	25.81	13.3	30.25	12.9	31.46	12.1	31.51	12.7	31.52	13.3	31.61
7	25-27 June	15.3	21.51	14.9	25.40	14.4	27.97	14.3	27.18	13.8	29.62	13.8	30.82
8	6-8 July	14.6	28.05	14.3	29.40	14.2	29.50	14.2	30.78	13.7	31.47	14.2	31.39
9	13-15 July	9.5	32.93	12.3	31.63	12.0	31.71	12.6	31.35	--	--	--	--
10	27-29 July	9.1	33.00	11.9	32.43	12.5	32.33	13.2	32.12	13.4	32.13	--	--

Table 6. Near-surface (1-m depth) salinity and temperature along two transect lines off the Columbia River mouth, April–July 1999. Dashes indicate missing data. Continued.

		Columbia River stations (approximate distance [nautical miles] from shore)											
		4		7		10		15		20		25	
		Temp.	Salin.	Temp.	Salin.	Temp.	Salin.	Temp.	Salin.	Temp.	Salin.	Temp.	Salin.
Cruise	Date	(°C)	(‰)	(°C)	(‰)	(°C)	(‰)	(°C)	(‰)	(°C)	(‰)	(°C)	(‰)
1	13-15 April	--	--	9.9	26.87	--	--	--	--	9.6	22.31	--	--
2	22-24 April	9.5	29.06	9.9	28.30	10.4	23.35	11.1	24.79	10.8	16.66	11.1	21.63
3	4-6 May	11.6	20.33	11.7	21.09	11.6	18.29	11.3	20.53	--	--	10.9	31.59
4	13-15 May	10.9	26.97	--	--	11.0	15.50	--	--	11.4	22.63	11.5	24.19
5	27-29 May	9.4	30.08	11.1	23.32	11.0	22.36	11.7	20.65	11.1	30.85	12.2	28.70
6	12-14 June	14.7	24.79	15.0	23.69	14.2	19.72	15.3	23.72	14.9	20.61	13.4	31.45
7	25-27 June	13.6	27.79	13.6	23.21	--	--	14.0	17.58	14.6	24.94	14.3	29.87
8	6-8 July	13.7	26.83	14.0	22.62	12.4	25.93	14.0	20.48	13.6	24.38	13.9	31.28
9	13-15 July	11.0	28.01	10.5	27.43	11.8	23.57	11.3	27.32	13.0	31.41	13.8	30.92
10	27-29 July	10.5	31.92	14.4	19.40	12.5	26.46	13.6	22.77	13.3	31.89	15.3	28.82

DISCUSSION

The 264-rope trawl with Lite doors was a very effective gear for sampling pelagic fishes. This gear enabled us to hire a local commercial fishing vessel to perform our sampling. We were also able to effectively fish this gear in fairly rough weather, and only once were we forced to break off sampling because of rough seas.

While laboratory analysis of the predator stomachs is not complete, initial analysis of the stomach contents found only one occurrence of salmonid feeding (by Pacific hake), and we believe this was net feeding. We found most hake feeding on euphausiids. However, length-frequency data indicate that many Pacific hake were large enough to eat fish. Livingston and Alton (1982) found that hake longer than 400 mm SL had fish as a significant portion of their diet, with the importance of fish in the diet of hake increasing with length. We captured very few large fish (>500 mm SL), which are known to often have fish as a majority of their diet (Bailey et al. 1982). We were initially unsure whether the lack of large Pacific hake in our catches was a result of their avoidance of our gear or their absence in the area. However, since we used multiple gear types in 1998, including a commercial hake net, and still captured few large hake, we believe that very large hake did not occur in the study area during our survey periods.

Purse-seine studies in the 1980s (Brodeur and Pearcy 1986) caught large numbers of northern anchovy and market squid (*Loligo opalescens*) off Oregon. We captured relatively few of these species; our catches were dominated by Pacific sardine and Pacific herring. Our survey data lend supporting evidence that the northern subpopulation of northern anchovy has abruptly declined (Emmett et al. 1997) and has been replaced by sardine. The cycle of replacement of anchovy with sardine is well documented and has been occurring for centuries (Baumgartner et al. 1992). Nevertheless, how the replacement of one baitfish species for another affects salmonid marine survival is unclear. What is obvious is that while sardine have become abundant off Oregon and Washington, marine survival of salmonids has declined.

The length-frequency distributions of anchovy and sardines show large differences in size. Anchovy has a relatively short life (most do not live beyond 4 years) and does not grow very large (maximum size is 248 mm total length [TL], but it rarely exceeds 178 mm TL) (Baxter 1967, Hart 1973). Pacific sardine has a relatively long life (8–10 years) and grows larger than anchovy. While sardine do spawn off the Oregon/Washington coast, we captured few subyearling or small sardine that would be of similar size to anchovy.

This size difference between sardine and anchovy could have significant consequences for juvenile salmonid survival. Most juvenile chinook and coho salmon migrating to sea during April–June from the Columbia River, range from 100 to 170 mm FL (McCabe et al. 1983, Bottom et al. 1984, Dawley et al. 1986). This size range corresponds closely with the size range of northern anchovy. Since piscivorous predators are often size selective (not necessarily species selective) (see Sogard 1997 for review), the reduction of anchovy abundance may have increased predation rates on salmonids by piscivorous birds, mammals, and fishes that preferentially prey on fishes within this size range.

Pacific herring, which was abundant, showed a length-frequency distribution that encompassed the size range of anchovy (Fig. 6). If size-dependent predation was occurring, abundant Pacific herring resources should have reduced this predation pressure on salmonids. However, most Pacific herring captured were older, larger individuals, with only 26% of the Pacific herring captured less than 160 mm FL.

Laboratory analysis of predator fish stomachs is still underway. Nevertheless, we have found baitfish to be a very important component to Pacific hake's diet. The size and species consumed should help clarify if size-dependent predation is occurring.

The large numbers of mackerel, sardine, and hake now residing in the Oregon/Washington coastal zone may also be competing with juvenile salmonids for prey resources. Gross examination (while at sea) of hundreds of mackerel, hake, and sardine stomachs indicated nearly all were feeding on euphausiids. Euphausiids are also important prey for juvenile salmonids (Brodeur and Pearcy 1990). We hypothesize that abundant euphausiid resources may enable more juvenile salmonids to outgrow the size window where predation is intense. Abundant euphausiid resources may also inhibit certain predators from switching to prey on fishes.

Coho salmon ocean survival was 1% in 1998 and estimated to be over 2% in 1999 (Pacific Fishery Management Council [PFMC] 2000). This is much higher than the 0.5% survival during most of the 1990s. It is unfortunate that we did not discover the 264-rope trawl until late June 1998, because this would have allowed direct comparison of our catches between years. Nevertheless, as salmonid ocean survival fluctuates, future surveys will be able to track changes in the nearshore fish community structure and in fish feeding habits that affect salmonid survival. These data can then be statistically related to salmonid marine survival. It is probable that both predation and competition play a role in salmonid ocean survival. Predation on salmonids is mediated by predator abundance, baitfish community structure (e.g., anchovy abundance), and salmonid growth rates. Salmonid growth rates are in turn influenced by food resources, which are affected by competition with other fishes, ocean productivity, and other factors.

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APPENDIX I:

SUMMARY OF TRAWL DATA

Appendix 1. Summary data for each trawl including location, gear used, time and date, total number and number of each species caught during a study of predatory fish off the Columbia River in 1998 and 1999.

Haul #:	1	**Latitude:**	46.422 **N**	**Longitude:**	124.337 **W**
Net type:	Commercial hake trawl	**Door type:**	5-m Thyboron	**Codend liner:**	
Start date/time:	04/16/1998 2:30:00 PM	**Tow time (minutes):**	5	**Tow distance (km):**	0.50
Speed (km/h):	6.0	**Tow direction (degrees):**	244	**Total caught:**	1

Common name	Scientific name	Number caught
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1

Haul #:	2	**Latitude:**	46.284 **N**	**Longitude:**	124.333 **W**
Net type:	Commercial hake trawl	**Door type:**	5-m Thyboron	**Codend liner:**	
Start date/time:	04/16/1998 10:29:00 PM	**Tow time (minutes):**	34	**Tow distance (km):**	4.21
Speed (km/h):	7.4	**Tow direction (degrees):**	185	**Total caught:**	49

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	49

Haul #:	3	**Latitude:**	46.198 **N**	**Longitude:**	124.362 **W**
Net type:	Commercial hake trawl	**Door type:**	5-m Thyboron	**Codend liner:**	
Start date/time:	04/17/1998 1:18:00 AM	**Tow time (minutes):**	39	**Tow distance (km):**	9.22
Speed (km/h):	14.2	**Tow direction (degrees):**	210	**Total caught:**	6

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	2
Pacific hake	*Merluccius productus*	2
Pacific sanddab	*Citharichthys sordidus*	1
Pacific sardine	*Sardinops sagax*	1

Haul #:	4	**Latitude:**	46.137 **N**	**Longitude:**	124.443 **W**
Net type:	Commercial hake trawl	**Door type:**	5-m Thyboron	**Codend liner:**	
Start date/time:	04/17/1998 2:20:00 AM	**Tow time (minutes):**	87	**Tow distance (km):**	8.87
Speed (km/h):	6.1	**Tow direction (degrees):**	27	**Total caught:**	12

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	2
Pacific sanddab	*Citharichthys sordidus*	4
Pacific sardine	*Sardinops sagax*	6

Appendix 1. Continued.

Haul #: 5 **Latitude:** 46.246 **N** **Longitude:** 124.358 **W**
Net type: Commercial hake trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 04/17/1998 4:49:00 AM **Tow time (minutes):** 124 **Tow distance (km):** 13.68
Speed (km/h): 6.6 **Tow direction (degrees):** 3 **Total caught:** 8

Common name	Scientific name	Number caught
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Northern anchovy	*Engraulis mordax*	4
Whitebait smelt	*Allosmerus elongatus*	3

Haul #: 6 **Latitude:** 46.400 **N** **Longitude:** 124.402 **W**
Net type: Commercial hake trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 04/17/1998 9:45:00 AM **Tow time (minutes):** 52 **Tow distance (km):** 5.39
Speed (km/h): 6.2 **Tow direction (degrees):** 177 **Total caught:** 140

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	1
Pacific sardine	*Sardinops sagax*	1
Pacific herring	*Clupea pallasi*	5
Pacific hake	*Merluccius productus*	116
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	9
Chub mackerel	*Scomber japonicus*	8

Haul #: 7 **Latitude:** 45.840 **N** **Longitude:** 124.043 **W**
Net type: Commercial hake trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 04/17/1998 9:55:00 PM **Tow time (minutes):** 40 **Tow distance (km):** 6.17
Speed (km/h): 9.3 **Tow direction (degrees):** 7 **Total caught:** 14

Common name	Scientific name	Number caught
Northern anchovy	*Engraulis mordax*	5
Pacific sardine	*Sardinops sagax*	4
Whitebait smelt	*Allosmerus elongatus*	5

Haul #: 8 **Latitude:** 45.913 **N** **Longitude:** 124.102 **W**
Net type: Commercial hake trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 04/17/1998 11:30:00 PM **Tow time (minutes):** 57 **Tow distance (km):** 4.92
Speed (km/h): 5.2 **Tow direction (degrees):** 345 **Total caught:** 0

Common name	Scientific name	Number caught
Northern anchovy	*Engraulis mordax*	0
Pacific herring	*Clupea pallasi*	0
Pacific sardine	*Sardinops sagax*	0
Whitebait smelt	*Allosmerus elongatus*	0

Appendix 1. Continued.

Haul #: 9 **Latitude:** 46.252 **N** **Longitude:** 124.368 **W**
Net type: Commercial hake trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 04/18/1998 4:29:00 AM **Tow time (minutes):** 76 **Tow distance (km):** 9.25
Speed (km/h): 7.3 **Tow direction (degrees):** 39 **Total caught:** 7

Common name	Scientific name	Number caught
Yellowtail rockfish	*Sebastes flavidus*	1
Northern anchovy	*Engraulis mordax*	3
Pacific hake	*Merluccius productus*	2
Pacific sanddab	*Citharichthys sordidus*	1

Haul #: 10 **Latitude:** 46.353 **N** **Longitude:** 124.263 **W**
Net type: Commercial hake trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 04/18/1998 6:47:00 AM **Tow time (minutes):** 35 **Tow distance (km):** 5.46
Speed (km/h): 9.4 **Tow direction (degrees):** 162 **Total caught:** 81

Common name	Scientific name	Number caught
Black rockfish	*Sebastes melanops*	18
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	14
Dover sole	*Microstomus pacificus*	5
Pacific hake	*Merluccius productus*	41
Pacific pomfret	*Brama japonica*	1
Spiny dogfish	*Squalus acanthias*	1
Spotted ratfish	*Hydrolagus colliei*	1

Haul #: 11 **Latitude:** 46.601 **N** **Longitude:** 124.497 **W**
Net type: rock-hopper **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 04/30/1998 9:52:00 PM **Tow time (minutes):** 42 **Tow distance (km):** 4.80
Speed (km/h): 6.9 **Tow direction (degrees):** 153 **Total caught:** 26

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	26

Haul #: 12 **Latitude:** 46.542 **N** **Longitude:** 124.453 **W**
Net type: rock-hopper **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 04/30/1998 11:25:00 PM **Tow time (minutes):** 89 **Tow distance (km):** 10.81
Speed (km/h): 7.3 **Tow direction (degrees):** 173 **Total caught:** 0

Common name	Scientific name	Number caught
No fish caught		0

Appendix 1. Continued.

Haul #: 13 **Latitude:** 46.199 **N** **Longitude:** 124.607 **W**
Net type: rock-hopper **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 05/01/1998 9:16:00 PM **Tow time (minutes):** 66 **Tow distance (km):** 6.21
Speed (km/h): 5.6 **Tow direction (degrees):** 99 **Total caught:** 330

Common name	Scientific name	Number caught
English sole	*Pleuronectes vetulus*	4
Yellowtail rockfish	*Sebastes flavidus*	1
Spiny dogfish	*Squalus acanthias*	2
Pacific hake	*Merluccius productus*	320
Pacific sanddab	*Citharichthys sordidus*	3

Haul #: 14 **Latitude:** 46.220 **N** **Longitude:** 124.402 **W**
Net type: rock-hopper **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 05/02/1998 1:57:00 AM **Tow time (minutes):** 95 **Tow distance (km):** 10.31
Speed (km/h): 6.5 **Tow direction (degrees):** 257 **Total caught:** 13

Common name	Scientific name	Number caught
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Pacific hake	*Merluccius productus*	6
Pacific herring	*Clupea pallasi*	5

Haul #: 15 **Latitude:** 46.583 **N** **Longitude:** 124.349 **W**
Net type: rock-hopper **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 05/15/1998 9:22:00 PM **Tow time (minutes):** 34 **Tow distance (km):** 3.89
Speed (km/h): 6.9 **Tow direction (degrees):** 162 **Total caught:** 29

Common name	Scientific name	Number caught
Northern anchovy	*Engraulis mordax*	9
Pacific hake	*Merluccius productus*	2
Pacific sanddab	*Citharichthys sordidus*	17
Spiny dogfish	*Squalus acanthias*	1

Haul #: 16 **Latitude:** 46.516 **N** **Longitude:** 124.338 **W**
Net type: rock-hopper **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 05/15/1998 11:43:00 PM **Tow time (minutes):** 73 **Tow distance (km):** 7.72
Speed (km/h): 6.3 **Tow direction (degrees):** 354 **Total caught:** 1065

Common name	Scientific name	Number caught
Pacific sardine	*Sardinops sagax*	4
Pacific sanddab	*Citharichthys sordidus*	190
California market squid	*Loligo opalescens*	18
Northern anchovy	*Engraulis mordax*	789
Spiny dogfish	*Squalus acanthias*	1
Pacific hake	*Merluccius productus*	63

Appendix 1. Continued.

Haul #: 17 **Latitude:** 45.966 **N** **Longitude:** 124.199 **W**
Net type: rock-hopper **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 05/16/1998 9:44:00 AM **Tow time (minutes):** 12 **Tow distance (km):** 1.02
Speed (km/h): 5.1 **Tow direction (degrees):** 336 **Total caught:** 26

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	26

Haul #: 18 **Latitude:** 45.979 **N** **Longitude:** 124.194 **W**
Net type: rock-hopper **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 05/16/1998 9:26:00 PM **Tow time (minutes):** 94 **Tow distance (km):** 9.08
Speed (km/h): 5.8 **Tow direction (degrees):** 171 **Total caught:** 54

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	41
Pacific sanddab	*Citharichthys sordidus*	13

Haul #: 19 **Latitude:** 46.135 **N** **Longitude:** 124.137 **W**
Net type: rock-hopper **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 05/17/1998 3:12:00 AM **Tow time (minutes):** 66 **Tow distance (km):** 7.43
Speed (km/h): 6.8 **Tow direction (degrees):** 152 **Total caught:** 0

Common name	Scientific name	Number caught
No fish caught		0

Haul #: 20 **Latitude:** 46.191 **N** **Longitude:** 124.513 **W**
Net type: rock-hopper **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 05/17/1998 8:02:00 AM **Tow time (minutes):** 64 **Tow distance (km):** 6.75
Speed (km/h): 6.3 **Tow direction (degrees):** 108 **Total caught:** 28

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	8
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	3
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	5
Pacific herring	*Clupea pallasi*	12

Appendix 1. Continued.

Haul #: 21 **Latitude:** 46.345 **N** **Longitude:** 124.301 **W**
Net type: #4 rope trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 05/31/1998 8:28:00 PM **Tow time (minutes):** 103 **Tow distance (km):** 11.02
Speed (km/h): 6.4 **Tow direction (degrees):** 188 **Total caught:** 950

Common name	Scientific name	Number caught
Northern anchovy	*Engraulis mordax*	0
Pacific hake	*Merluccius productus*	65
Chub mackerel	*Scomber japonicus*	6
California market squid	*Loligo opalescens*	0
Pacific sardine	*Sardinops sagax*	879

Haul #: 22 **Latitude:** 46.603 **N** **Longitude:** 124.293 **W**
Net type: #4 rope trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 06/01/1998 3:08:00 AM **Tow time (minutes):** 39 **Tow distance (km):** 4.78
Speed (km/h): 7.4 **Tow direction (degrees):** 167 **Total caught:** 260

Common name	Scientific name	Number caught
Northern anchovy	*Engraulis mordax*	200
Pacific hake	*Merluccius productus*	39
Pacific sanddab	*Citharichthys sordidus*	21
Smelts	*Osmeridae*	0

Haul #: 23 **Latitude:** 46.518 **N** **Longitude:** 124.364 **W**
Net type: #4 rope trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 06/01/1998 5:46:00 AM **Tow time (minutes):** 46 **Tow distance (km):** 6.15
Speed (km/h): 8.0 **Tow direction (degrees):** 207 **Total caught:** 0

Common name	Scientific name	Number caught
No fish caught		0

Haul #: 24 **Latitude:** 46.349 **N** **Longitude:** 124.262 **W**
Net type: #4 rope trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 06/01/1998 8:33:00 AM **Tow time (minutes):** 67 **Tow distance (km):** 5.93
Speed (km/h): 5.3 **Tow direction (degrees):** 349 **Total caught:** 0

Common name	Scientific name	Number caught
No fish caught		0

Appendix 1. Continued.

Haul #: 25 **Latitude:** 45.977 **N** **Longitude:** 124.287 **W**
Net type: #4 rope trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 06/01/1998 3:54:00 PM **Tow time (minutes):** 42 **Tow distance (km):** 3.89
Speed (km/h): 5.6 **Tow direction (degrees):** 172 **Total caught:** 4070

Common name	Scientific name	Number caught
Pacific sardine	*Sardinops sagax*	152
Northern anchovy	*Engraulis mordax*	10
Pacific hake	*Merluccius productus*	3880
Pacific herring	*Clupea pallasi*	10
Chub mackerel	*Scomber japonicus*	18

Haul #: 26 **Latitude:** 46.095 **N** **Longitude:** 124.482 **W**
Net type: #4 rope trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 06/01/1998 10:26:00 PM **Tow time (minutes):** 62 **Tow distance (km):** 7.26
Speed (km/h): 7.0 **Tow direction (degrees):** 131 **Total caught:** 1287

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	1263
Pacific sardine	*Sardinops sagax*	0
Spiny dogfish	*Squalus acanthias*	1
Chub mackerel	*Scomber japonicus*	5
California market squid	*Loligo opalescens*	17
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Northern anchovy	*Engraulis mordax*	0

Haul #: 27 **Latitude:** 46.106 **N** **Longitude:** 124.316 **W**
Net type: #4 rope trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 06/02/1998 2:58:00 AM **Tow time (minutes):** 32 **Tow distance (km):** 3.63
Speed (km/h): 6.8 **Tow direction (degrees):** 351 **Total caught:** 0

Common name	Scientific name	Number caught
No fish caught		0

Haul #: 28 **Latitude:** 46.291 **N** **Longitude:** 124.494 **W**
Net type: #4 rope trawl **Door type:** 5-m Thyboron **Codend liner:**
Start date/time: 06/02/1998 6:42:00 AM **Tow time (minutes):** 40 **Tow distance (km):** 4.12
Speed (km/h): 6.2 **Tow direction (degrees):** 95 **Total caught:** 12

Common name	Scientific name	Number caught
Jack mackerel	*Trachurus symmetricus*	4
Northern anchovy	*Engraulis mordax*	1
Pacific hake	*Merluccius productus*	4
Pacific sardine	*Sardinops sagax*	3

Appendix 1. Continued.

Haul #: 29 **Latitude:** 46.567 **N** **Longitude:** 124.225 **W**
Net type: #4 rope trawl **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 06/12/1998 10:55:00 AM **Tow time (minutes):** 36 **Tow distance (km):** 3.65
Speed (km/h): 6.1 **Tow direction (degrees):** 201 **Total caught:** 152

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	0
Pacific sanddab	*Citharichthys sordidus*	1
Pacific hake	*Merluccius productus*	3
Northern anchovy	*Engraulis mordax*	148
Pacific sardine	*Sardinops sagax*	0

Haul #: 30 **Latitude:** 46.597 **N** **Longitude:** 124.247 **W**
Net type: #4 rope trawl **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 06/13/1998 4:32:00 AM **Tow time (minutes):** 101 **Tow distance (km):** 7.07
Speed (km/h): 4.2 **Tow direction (degrees):** 178 **Total caught:** 64

Common name	Scientific name	Number caught
Blue shark	*Prionace glauca*	1
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	3
Northern anchovy	*Engraulis mordax*	0
Pacific herring	*Clupea pallasi*	60
Pacific sardine	*Sardinops sagax*	0

Haul #: 31 **Latitude:** 46.165 **N** **Longitude:** 124.249 **W**
Net type: #4 rope trawl **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 06/13/1998 7:18:00 PM **Tow time (minutes):** 98 **Tow distance (km):** 10.73
Speed (km/h): 6.6 **Tow direction (degrees):** 170 **Total caught:** 6

Common name	Scientific name	Number caught
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	4
Spiny dogfish	*Squalus acanthias*	2

Appendix 1. Continued.

Haul #: 32 **Latitude:** 46.297 **N** **Longitude:** 124.216 **W**
Net type: #4 rope trawl **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 06/13/1998 11:46:00 PM **Tow time (minutes):** 51 **Tow distance (km):** 6.06
Speed (km/h): 7.1 **Tow direction (degrees):** 185 **Total caught:** 379

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	344
Spiny dogfish	*Squalus acanthias*	1
Pacific herring	*Clupea pallasi*	0
Pacific sanddab	*Citharichthys sordidus*	12
Pacific sardine	*Sardinops sagax*	0
English sole	*Pleuronectes vetulus*	17
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	5
California market squid	*Loligo opalescens*	0
Northern anchovy	*Engraulis mordax*	0

Haul #: 33 **Latitude:** 46.341 **N** **Longitude:** 124.208 **W**
Net type: #4 rope trawl **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 06/14/1998 2:19:00 AM **Tow time (minutes):** 48 **Tow distance (km):** 5.98
Speed (km/h): 7.5 **Tow direction (degrees):** 162 **Total caught:** 215

Common name	Scientific name	Number caught
Smelts	*Osmeridae*	0
Snailfish	*Cyclopteridae*	1
Pacific sardine	*Sardinops sagax*	0
Pacific sandfish	*Trichodon trichodon*	2
Pacific hake	*Merluccius productus*	181
Northern anchovy	*Engraulis mordax*	0
Black rockfish	*Sebastes melanops*	1
English sole	*Pleuronectes vetulus*	1
Pacific sanddab	*Citharichthys sordidus*	29

Haul #: 34 **Latitude:** 46.317 **N** **Longitude:** 124.395 **W**
Net type: #4 rope trawl **Door type:** 3-m suber krube **Codend liner:**
Start date/time: 06/14/1998 8:26:00 AM **Tow time (minutes):** 48 **Tow distance (km):** 4.30
Speed (km/h): 5.4 **Tow direction (degrees):** 128 **Total caught:** 429

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	420
California market squid	*Loligo opalescens*	0
Spiny dogfish	*Squalus acanthias*	1
Pacific hake	*Merluccius productus*	8

Appendix 1. Continued.

Haul #: 35 **Latitude:** 46.624 **N** **Longitude:** 124.276 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 06/27/1998 10:05:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.87
Speed (km/h): 7.7 **Tow direction (degrees):** 207 **Total caught:** 86

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	29
Pacific sardine	*Sardinops sagax*	1
Spiny dogfish	*Squalus acanthias*	4
Whitebait smelt	*Allosmerus elongatus*	50
Northern anchovy	*Engraulis mordax*	2

Haul #: 36 **Latitude:** 46.600 **N** **Longitude:** 124.293 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 06/27/1998 11:50:00 PM **Tow time (minutes):** 32 **Tow distance (km):** 3.84
Speed (km/h): 7.2 **Tow direction (degrees):** 206 **Total caught:** 128

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	0
Pacific sardine	*Sardinops sagax*	52
Smelts	*Osmeridae*	0
Pacific hake	*Merluccius productus*	55
Northern anchovy	*Engraulis mordax*	0
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	2
Spiny dogfish	*Squalus acanthias*	19

Haul #: 37 **Latitude:** 46.597 **N** **Longitude:** 124.307 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 06/28/1998 1:44:00 AM **Tow time (minutes):** 26 **Tow distance (km):** 2.98
Speed (km/h): 6.9 **Tow direction (degrees):** 207 **Total caught:** 1066

Common name	Scientific name	Number caught
Northern anchovy	*Engraulis mordax*	0
Spiny dogfish	*Squalus acanthias*	20
Pacific sardine	*Sardinops sagax*	837
Pacific hake	*Merluccius productus*	201
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	8
California market squid	*Loligo opalescens*	0
American shad	*Alosa sapidissima*	0
Pacific herring	*Clupea pallasi*	0

Appendix 1. Continued.

Haul #: 38 **Latitude:** 46.576 **N** **Longitude:** 124.406 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 06/28/1998 4:07:00 AM **Tow time (minutes):** 34 **Tow distance (km):** 4.05
Speed (km/h): 7.1 **Tow direction (degrees):** 189 **Total caught:** 375

Common name	Scientific name	Number caught
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Pacific sardine	*Sardinops sagax*	331
Pacific sanddab	*Citharichthys sordidus*	1
Spiny dogfish	*Squalus acanthias*	2
Pacific herring	*Clupea pallasi*	0
Chub mackerel	*Scomber japonicus*	21
California market squid	*Loligo opalescens*	0
American shad	*Alosa sapidissima*	1
Pacific hake	*Merluccius productus*	18

Haul #: 39 **Latitude:** 45.935 **N** **Longitude:** 124.136 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 06/28/1998 9:05:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 3.85
Speed (km/h): 7.5 **Tow direction (degrees):** 176 **Total caught:** 47

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	3
Chub mackerel	*Scomber japonicus*	1
Northern anchovy	*Engraulis mordax*	1
Pacific hake	*Merluccius productus*	5
Pacific herring	*Clupea pallasi*	35
Pacific sardine	*Sardinops sagax*	2

Haul #: 40 **Latitude:** 45.892 **N** **Longitude:** 124.181 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 06/28/1998 10:38:00 PM **Tow time (minutes):** 46 **Tow distance (km):** 4.93
Speed (km/h): 6.4 **Tow direction (degrees):** 355 **Total caught:** 1085

Common name	Scientific name	Number caught
Jack mackerel	*Trachurus symmetricus*	1
Pacific herring	*Clupea pallasi*	0
Pacific sardine	*Sardinops sagax*	45
Chub mackerel	*Scomber japonicus*	277
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Lamprey	*Petromyzontidae*	3
Pacific hake	*Merluccius productus*	758

Appendix 1. Continued.

Haul #: 41 **Latitude:** 45.926 **N** **Longitude:** 124.179 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 06/29/1998 1:30:00 AM **Tow time (minutes):** 20 **Tow distance (km):** 2.45
Speed (km/h): 7.4 **Tow direction (degrees):** 176 **Total caught:** 1134

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	1
Bait fish		0
Chub mackerel	*Scomber japonicus*	20
Lamprey	*Petromyzontidae*	2
Pacific hake	*Merluccius productus*	1025
Pacific sardine	*Sardinops sagax*	86

Haul #: 42 **Latitude:** 45.912 **N** **Longitude:** 124.071 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 06/29/1998 3:32:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 3.03
Speed (km/h): 5.9 **Tow direction (degrees):** 9 **Total caught:** 5

Common name	Scientific name	Number caught
Spiny dogfish	*Squalus acanthias*	3
Bait		0
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	1
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1

Haul #: 43 **Latitude:** 46.032 **N** **Longitude:** 124.021 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 06/29/1998 5:15:00 AM **Tow time (minutes):** 49 **Tow distance (km):** 4.81
Speed (km/h): 5.9 **Tow direction (degrees):** 348 **Total caught:** 3

Common name	Scientific name	Number caught
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2

Appendix 1. Continued.

Haul #: 44 **Latitude:** 46.626 **N** **Longitude:** 124.334 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/12/1998 10:27:00 PM **Tow time (minutes):** 40 **Tow distance (km):** 4.61
Speed (km/h): 6.9 **Tow direction (degrees):** 168 **Total caught:** 127

Common name	Scientific name	Number caught
Bait fish		0
California market squid	*Loligo opalescens*	34
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	2
Chub mackerel	*Scomber japonicus*	4
Jack mackerel	*Trachurus symmetricus*	1
Pacific hake	*Merluccius productus*	16
Pacific sardine	*Sardinops sagax*	64
Rex sole	*Errex zachirus*	1
Spiny dogfish	*Squalus acanthias*	5

Haul #: 45 **Latitude:** 46.560 **N** **Longitude:** 124.363 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/13/1998 12:45:00 AM **Tow time (minutes):** 32 **Tow distance (km):** 3.87
Speed (km/h): 7.3 **Tow direction (degrees):** 179 **Total caught:** 4267

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	36
Pacific sardine	*Sardinops sagax*	3
Pacific herring	*Clupea pallasi*	4193
Shark	*Chondrichthyes*	1
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
California market squid	*Loligo opalescens*	5
Pacific hake	*Merluccius productus*	28
Northern anchovy	*Engraulis mordax*	0

Haul #: 46 **Latitude:** 46.493 **N** **Longitude:** 124.388 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/13/1998 2:45:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.28
Speed (km/h): 6.6 **Tow direction (degrees):** 173 **Total caught:** 5431

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	0
Blue shark	*Prionace glauca*	3
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	2
Chub mackerel	*Scomber japonicus*	80
Pacific hake	*Merluccius productus*	60
Pacific herring	*Clupea pallasi*	5285
Shark	*Chondrichthyes*	1

Appendix 1. Continued.

Haul #: 47 **Latitude:** 46.406 **N** **Longitude:** 124.423 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/13/1998 4:37:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.44
Speed (km/h): 6.9 **Tow direction (degrees):** 162 **Total caught:** 183

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	4
Pacific herring	*Clupea pallasi*	167
Jack mackerel	*Trachurus symmetricus*	2
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	1
California market squid	*Loligo opalescens*	8
Pacific hake	*Merluccius productus*	1

Haul #: 48 **Latitude:** 45.931 **N** **Longitude:** 124.063 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/13/1998 9:55:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 2.93
Speed (km/h): 5.9 **Tow direction (degrees):** 343 **Total caught:** 857

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	5
Pacific herring	*Clupea pallasi*	12
Pacific sardine	*Sardinops sagax*	781
Smelts	*Osmeridae*	59

Haul #: 49 **Latitude:** 45.971 **N** **Longitude:** 124.056 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/13/1998 11:17:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.26
Speed (km/h): 6.5 **Tow direction (degrees):** 175 **Total caught:** 4680

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	18
Pacific sardine	*Sardinops sagax*	4657
Spiny dogfish	*Squalus acanthias*	5

Appendix 1. Continued.

Haul #: 50 **Latitude:** 45.969 **N** **Longitude:** 124.164 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/14/1998 12:59:00 AM **Tow time (minutes):** 28 **Tow distance (km):** 4.27
Speed (km/h): 9.2 **Tow direction (degrees):** 7 **Total caught:** 155

Common name	Scientific name	Number caught
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Spiny dogfish	*Squalus acanthias*	2
Smelts	*Osmeridae*	0
Shark	*Chondrichthyes*	1
Pacific hake	*Merluccius productus*	80
Pacific herring	*Clupea pallasi*	17
American shad	*Alosa sapidissima*	4
Pacific sardine	*Sardinops sagax*	50

Haul #: 51 **Latitude:** 46.048 **N** **Longitude:** 124.277 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/14/1998 2:44:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.17
Speed (km/h): 6.3 **Tow direction (degrees):** 343 **Total caught:** 1292

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	12
Pacific sardine	*Sardinops sagax*	20
Pacific hake	*Merluccius productus*	1220
Lamprey	*Petromyzontidae*	1
Coho salmon - adult	*Oncorhynchus kisutch*	1
Chub mackerel	*Scomber japonicus*	27
American shad	*Alosa sapidissima*	6
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	4
Jack mackerel	*Trachurus symmetricus*	1

Haul #: 52 **Latitude:** 46.104 **N** **Longitude:** 124.386 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/14/1998 4:04:00 AM **Tow time (minutes):** 76 **Tow distance (km):** 3.60
Speed (km/h): 2.8 **Tow direction (degrees):** 347 **Total caught:** 120

Common name	Scientific name	Number caught
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	1
Pacific herring	*Clupea pallasi*	70
Pacific hake	*Merluccius productus*	32
American shad	*Alosa sapidissima*	5
Chub mackerel	*Scomber japonicus*	7
California market squid	*Loligo opalescens*	3
Jack mackerel	*Trachurus symmetricus*	2

Appendix 1. Continued.

Haul #: 53 **Latitude:** 46.615 **N** **Longitude:** 124.275 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/27/1998 10:37:00 PM **Tow time (minutes):** 33 **Tow distance (km):** 3.79
Speed (km/h): 6.9 **Tow direction (degrees):** 189 **Total caught:** 4072

Common name	Scientific name	Number caught
Pacific sanddab	*Citharichthys sordidus*	2
Pacific herring	*Clupea pallasi*	2267
Whitebait smelt	*Allosmerus elongatus*	742
Spiny dogfish	*Squalus acanthias*	6
Soupfin shark	*Galeorhinus zyopterus*	2
California market squid	*Loligo opalescens*	4
Pacific hake	*Merluccius productus*	56
Northern anchovy	*Engraulis mordax*	977
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	5
Pacific sardine	*Sardinops sagax*	11

Haul #: 54 **Latitude:** 46.593 **N** **Longitude:** 124.407 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/28/1998 2:07:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 3.62
Speed (km/h): 7.0 **Tow direction (degrees):** 181 **Total caught:** 93

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	33
Pacific sardine	*Sardinops sagax*	2
Pacific hake	*Merluccius productus*	24
Lamprey	*Petromyzontidae*	1
Chub mackerel	*Scomber japonicus*	15
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1
California market squid	*Loligo opalescens*	6
American shad	*Alosa sapidissima*	5
Jack mackerel	*Trachurus symmetricus*	5
Soupfin shark	*Galeorhinus zyopterus*	1

Appendix 1. Continued.

Haul #: 55 **Latitude:** 46.538 **N** **Longitude:** 124.433 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/28/1998 3:24:00 AM **Tow time (minutes):** 34 **Tow distance (km):** 3.79
Speed (km/h): 6.7 **Tow direction (degrees):** 173 **Total caught:** 436

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	20
Pacific sardine	*Sardinops sagax*	200
Pacific herring	*Clupea pallasi*	156
Pacific hake	*Merluccius productus*	28
Jack mackerel	*Trachurus symmetricus*	1
Chub mackerel	*Scomber japonicus*	24
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
American shad	*Alosa sapidissima*	4
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2

Haul #: 56 **Latitude:** 46.413 **N** **Longitude:** 124.456 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/28/1998 5:07:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 3.83
Speed (km/h): 7.4 **Tow direction (degrees):** 173 **Total caught:** 158

Common name	Scientific name	Number caught
Jack mackerel	*Trachurus symmetricus*	41
Pacific herring	*Clupea pallasi*	22
Chub mackerel	*Scomber japonicus*	14
California market squid	*Loligo opalescens*	5
Pacific sardine	*Sardinops sagax*	76

Haul #: 57 **Latitude:** 44.834 **N** **Longitude:** 124.965 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/28/1998 9:45:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 3.69
Speed (km/h): 7.1 **Tow direction (degrees):** 4 **Total caught:** 110

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	32
Jack mackerel	*Trachurus symmetricus*	60
Pacific pomfret	*Brama japonica*	18

Appendix 1. Continued.

Haul #: 58 **Latitude:** 44.982 **N** **Longitude:** 124.977 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/28/1998 11:32:00 PM **Tow time (minutes):** 32 **Tow distance (km):** 4.05
Speed (km/h): 7.6 **Tow direction (degrees):** 359 **Total caught:** 47

Common name	Scientific name	Number caught
Pacific pomfret	*Brama japonica*	1
California market squid	*Loligo opalescens*	0
Jack mackerel	*Trachurus symmetricus*	30
Lantern fish	*Myctophidae*	12
Longfin Dragonfish	*Tactostoma macropus*	4

Haul #: 59 **Latitude:** 45.222 **N** **Longitude:** 124.931 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/29/1998 1:52:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 3.43
Speed (km/h): 6.6 **Tow direction (degrees):** 1 **Total caught:** 558

Common name	Scientific name	Number caught
Pacific pomfret	*Brama japonica*	1
Longfin Dragonfish	*Tactostoma macropus*	2
California market squid	*Loligo opalescens*	70
Lantern fish	*Myctophidae*	485

Haul #: 60 **Latitude:** 45.442 **N** **Longitude:** 124.704 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/29/1998 5:04:00 AM **Tow time (minutes):** 32 **Tow distance (km):** 4.05
Speed (km/h): 7.6 **Tow direction (degrees):** 187 **Total caught:** 56

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	1
Jack mackerel	*Trachurus symmetricus*	16
Pacific hake	*Merluccius productus*	39

Appendix 1. Continued.

Haul #: 61 **Latitude:** 45.954 **N** **Longitude:** 124.051 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/29/1998 9:41:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 3.60
Speed (km/h): 7.0 **Tow direction (degrees):** 6 **Total caught:** 381

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	20
Spiny dogfish	*Squalus acanthias*	5
Whitebait smelt	*Allosmerus elongatus*	70
Pacific sanddab	*Citharichthys sordidus*	27
Pacific lamprey	*Lampetra tridentata*	1
Coho salmon - adult	*Oncorhynchus kisutch*	1
Chub mackerel	*Scomber japonicus*	11
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	2
American shad	*Alosa sapidissima*	7
Pacific hake	*Merluccius productus*	237

Haul #: 62 **Latitude:** 46.114 **N** **Longitude:** 124.162 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/30/1998 12:55:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.53
Speed (km/h): 7.1 **Tow direction (degrees):** 0 **Total caught:** 295

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	6
Jack mackerel	*Trachurus symmetricus*	3
Pacific hake	*Merluccius productus*	106
Pacific herring	*Clupea pallasi*	1
Pacific sanddab	*Citharichthys sordidus*	2
Pacific sardine	*Sardinops sagax*	176
American shad	*Alosa sapidissima*	1

Haul #: 63 **Latitude:** 46.092 **N** **Longitude:** 124.301 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 07/30/1998 3:33:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.20
Speed (km/h): 6.4 **Tow direction (degrees):** 1 **Total caught:** 1887

Common name	Scientific name	Number caught
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Soupfin shark	*Galeorhinus zyopterus*	1
Pacific sardine	*Sardinops sagax*	268
Chub mackerel	*Scomber japonicus*	54
California market squid	*Loligo opalescens*	0
Pacific hake	*Merluccius productus*	1562
Lamprey	*Petromyzontidae*	1

Appendix 1. Continued.

Haul #: 64 **Latitude:** 46.571 **N** **Longitude:** 124.258 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 08/10/1998 10:07:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.42
Speed (km/h): 6.8 **Tow direction (degrees):** 180 **Total caught:** 387

Common name	Scientific name	Number caught
Northern anchovy	*Engraulis mordax*	9
Whitebait smelt	*Allosmerus elongatus*	186
Pacific sanddab	*Citharichthys sordidus*	40
Pacific hake	*Merluccius productus*	82
Chub mackerel	*Scomber japonicus*	10
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
American shad	*Alosa sapidissima*	3
Pacific herring	*Clupea pallasi*	56

Haul #: 65 **Latitude:** 46.521 **N** **Longitude:** 124.293 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 08/11/1998 12:40:00 AM **Tow time (minutes):** 32 **Tow distance (km):** 3.65
Speed (km/h): 6.9 **Tow direction (degrees):** 171 **Total caught:** 103

Common name	Scientific name	Number caught
Spiny dogfish	*Squalus acanthias*	8
Whitebait smelt	*Allosmerus elongatus*	3
Pacific herring	*Clupea pallasi*	10
Pacific sanddab	*Citharichthys sordidus*	3
Northern anchovy	*Engraulis mordax*	51
Chub mackerel	*Scomber japonicus*	9
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Pacific hake	*Merluccius productus*	18

Appendix 1. Continued.

Haul #: 66 **Latitude:** 46.462 **N** **Longitude:** 124.405 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 08/11/1998 2:22:00 AM **Tow time (minutes):** 35 **Tow distance (km):** 3.17
Speed (km/h): 5.4 **Tow direction (degrees):** 175 **Total caught:** 400

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	101
American shad	*Alosa sapidissima*	10
Pacific sanddab	*Citharichthys sordidus*	0
Pacific hake	*Merluccius productus*	39
Northern anchovy	*Engraulis mordax*	26
Chub mackerel	*Scomber japonicus*	20
California market squid	*Loligo opalescens*	2
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	2
Jack mackerel	*Trachurus symmetricus*	76
Pacific sardine	*Sardinops sagax*	124

Haul #: 67 **Latitude:** 46.397 **N** **Longitude:** 124.476 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 08/11/1998 5:07:00 AM **Tow time (minutes):** 64 **Tow distance (km):** 3.94
Speed (km/h): 3.7 **Tow direction (degrees):** 185 **Total caught:** 716

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	18
Skates	*Rajidae*	1
Pacific sardine	*Sardinops sagax*	44
Pacific herring	*Clupea pallasi*	359
Jack mackerel	*Trachurus symmetricus*	46
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1
American shad	*Alosa sapidissima*	1
Pacific hake	*Merluccius productus*	246

Appendix 1. Continued.

Haul #: 68 **Latitude:** 45.988 **N** **Longitude:** 124.076 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 08/11/1998 9:49:00 PM **Tow time (minutes):** 33 **Tow distance (km):** 3.52
Speed (km/h): 6.4 **Tow direction (degrees):** 344 **Total caught:** 439

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	13
Pacific herring	*Clupea pallasi*	159
Ragfish	*Icosteus aenigmaticus*	1
Coho salmon - adult	*Oncorhynchus kisutch*	1
Whitebait smelt	*Allosmerus elongatus*	260
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	3
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	1
Coho salmon - juvenile	*Oncorhynchus kisutch*	1

Haul #: 69 **Latitude:** 46.043 **N** **Longitude:** 124.138 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 08/11/1998 11:23:00 PM **Tow time (minutes):** 34 **Tow distance (km):** 3.73
Speed (km/h): 6.6 **Tow direction (degrees):** 337 **Total caught:** 28

Common name	Scientific name	Number caught
Pacific sanddab	*Citharichthys sordidus*	2
Pacific tomcod	*Microgadus proximus*	1
Pacific herring	*Clupea pallasi*	14
Pacific hake	*Merluccius productus*	4
Whitebait smelt	*Allosmerus elongatus*	7

Haul #: 70 **Latitude:** 46.094 **N** **Longitude:** 124.223 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 08/12/1998 12:44:00 AM **Tow time (minutes):** 41 **Tow distance (km):** 4.70
Speed (km/h): 6.9 **Tow direction (degrees):** 349 **Total caught:** 96

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	3
Pacific hake	*Merluccius productus*	76
Pacific herring	*Clupea pallasi*	4
Whitebait smelt	*Allosmerus elongatus*	13

Appendix 1. Continued.

Haul #: 71 **Latitude:** 46.138 **N** **Longitude:** 124.296 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 08/12/1998 3:00:00 AM **Tow time (minutes):** 35 **Tow distance (km):** 3.39
Speed (km/h): 5.8 **Tow direction (degrees):** 8 **Total caught:** 1781

Common name	Scientific name	Number caught
Coho salmon - adult	*Oncorhynchus kisutch*	4
Pacific hake	*Merluccius productus*	1772
Spiny dogfish	*Squalus acanthias*	1
Chub mackerel	*Scomber japonicus*	4

Haul #: 72 **Latitude:** 46.126 **N** **Longitude:** 124.111 **W**
Net type: nordic 264 rope trawl **Door type:** 3-m foam filled **Codend liner:**
Start date/time: 08/12/1998 6:08:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.50
Speed (km/h): 7.0 **Tow direction (degrees):** 244 **Total caught:** 31

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	15
Pacific sanddab	*Citharichthys sordidus*	1
Pacific hake	*Merluccius productus*	2
Coho salmon - juvenile	*Oncorhynchus kisutch*	5
Coho salmon - adult	*Oncorhynchus kisutch*	4
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	3

Haul #: 73 **Latitude:** 46.142 **N** **Longitude:** 124.178 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 04/13/1999 12:48:00 PM **Tow time (minutes):** 35 **Tow distance (km):** 3.38
Speed (km/h): 5.8 **Tow direction (degrees):** 218 **Total caught:** 246

Common name	Scientific name	Number caught
Whitebait smelt	*Allosmerus elongatus*	6
Northern anchovy	*Engraulis mordax*	204
Pacific herring	*Clupea pallasi*	5
Pacific staghorn sculpin	*Leptocottus armatus*	1
Starry flounder	*Platichthys stellatus*	1
California market squid	*Loligo opalescens*	29

Appendix 1. Continued.

Haul #:	74	**Latitude:**	46.149 **N**	**Longitude:**	124.158 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/14/1999 1:03:00 PM	**Tow time (minutes):**	59	**Tow distance (km):**	7.02
Speed (km/h):	7.1	**Tow direction (degrees):**	184	**Total caught:**	10

Common name	Scientific name	Number caught
Whitebait smelt	*Allosmerus elongatus*	8
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1

Haul #:	75	**Latitude:**	46.074 **N**	**Longitude:**	124.338 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/14/1999 3:25:00 PM	**Tow time (minutes):**	57	**Tow distance (km):**	4.85
Speed (km/h):	5.1	**Tow direction (degrees):**	2	**Total caught:**	1

Common name	Scientific name	Number caught
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1

Haul #:	76	**Latitude:**	46.122 **N**	**Longitude:**	124.452 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/14/1999 5:28:00 PM	**Tow time (minutes):**	42	**Tow distance (km):**	3.18
Speed (km/h):	4.5	**Tow direction (degrees):**	345	**Total caught:**	1

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	1

Haul #:	77	**Latitude:**	46.664 **N**	**Longitude:**	124.783 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/14/1999 11:20:00 PM	**Tow time (minutes):**	42	**Tow distance (km):**	3.12
Speed (km/h):	4.5	**Tow direction (degrees):**	182	**Total caught:**	8

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	8

Haul #:	78	**Latitude:**	46.645 **N**	**Longitude:**	124.609 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/15/1999 1:29:00 AM	**Tow time (minutes):**	36	**Tow distance (km):**	3.13
Speed (km/h):	5.2	**Tow direction (degrees):**	358	**Total caught:**	1

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	1

Appendix 1. Continued.

Haul #:	79	**Latitude:**	46.650 **N**	**Longitude:**	124.517 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/15/1999 3:21:00 AM	**Tow time (minutes):**	41	**Tow distance (km):**	2.88
Speed (km/h):	4.2	**Tow direction (degrees):**	158	**Total caught:**	16

Common name	Scientific name	Number caught
Pacific sanddab	*Citharichthys sordidus*	12
Whitebait smelt	*Allosmerus elongatus*	4

Haul #:	80	**Latitude:**	46.657 **N**	**Longitude:**	124.401 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/15/1999 5:30:00 AM	**Tow time (minutes):**	35	**Tow distance (km):**	4.15
Speed (km/h):	7.1	**Tow direction (degrees):**	178	**Total caught:**	16

Common name	Scientific name	Number caught
Surf smelt	*Hypomesus pretiosus*	1
Whitebait smelt	*Allosmerus elongatus*	4
Snailfish	*Cyclopteridae*	1
Pacific sanddab	*Citharichthys sordidus*	8
Eulachon	*Thaleichthys pacificus*	1
Sand sole	*Psettichthys melanostictus*	1

Haul #:	81	**Latitude:**	46.663 **N**	**Longitude:**	124.289 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/15/1999 7:28:00 AM	**Tow time (minutes):**	36	**Tow distance (km):**	3.56
Speed (km/h):	5.9	**Tow direction (degrees):**	173	**Total caught:**	2

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	1
Coho salmon - juvenile	*Oncorhynchus kisutch*	1

Haul #:	82	**Latitude:**	46.656 **N**	**Longitude:**	124.172 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/15/1999 9:21:00 AM	**Tow time (minutes):**	34	**Tow distance (km):**	3.19
Speed (km/h):	5.6	**Tow direction (degrees):**	180	**Total caught:**	172

Common name	Scientific name	Number caught
Starry flounder	*Platichthys stellatus*	33
Whitebait smelt	*Allosmerus elongatus*	2
Surf smelt	*Hypomesus pretiosus*	2
Smelts	*Osmeridae*	100
Pacific herring	*Clupea pallasi*	34
Unidentified bony fish	*Osteichthyes*	1

Appendix 1. Continued.

Haul #:	83	**Latitude:** 46.646 **N**		**Longitude:** 124.786 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/22/1999 11:38:00 PM	**Tow time (minutes):**	58	**Tow distance (km):**	5.71
Speed (km/h):	5.9	**Tow direction (degrees):**	168	**Total caught:**	2

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	2

Haul #:	84	**Latitude:** 46.591 **N**		**Longitude:** 124.608 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/23/1999 2:09:00 AM	**Tow time (minutes):**	51	**Tow distance (km):**	5.28
Speed (km/h):	6.2	**Tow direction (degrees):**	1	**Total caught:**	5

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	5

Haul #:	85	**Latitude:** 46.652 **N**		**Longitude:** 124.508 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/23/1999 4:16:00 AM	**Tow time (minutes):**	30	**Tow distance (km):**	3.15
Speed (km/h):	6.3	**Tow direction (degrees):**	168	**Total caught:**	4

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	4

Haul #:	86	**Latitude:** 46.620 **N**		**Longitude:** 124.404 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/23/1999 5:50:00 AM	**Tow time (minutes):**	21	**Tow distance (km):**	1.41
Speed (km/h):	4.0	**Tow direction (degrees):**	352	**Total caught:**	9

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	9

Haul #:	87	**Latitude:** 46.656 **N**		**Longitude:** 124.284 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/23/1999 7:21:00 AM	**Tow time (minutes):**	34	**Tow distance (km):**	3.75
Speed (km/h):	6.6	**Tow direction (degrees):**	161	**Total caught:**	1

Common name	Scientific name	Number caught
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1

Haul #:	88	**Latitude:** 46.130 **N**		**Longitude:** 124.568 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/23/1999 10:05:00 PM	**Tow time (minutes):**	30	**Tow distance (km):**	1.45
Speed (km/h):	2.9	**Tow direction (degrees):**	1	**Total caught:**	0

Common name	Scientific name	Number caught
No fish caught		0

Appendix 1. Continued.

Haul #:	89	**Latitude:**	46.152 **N**	**Longitude:**	124.455 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/24/1999 12:22:00 AM	**Tow time (minutes):**	30	**Tow distance (km):**	3.38
Speed (km/h):	6.8	**Tow direction (degrees):**	196	**Total caught:**	0

Common name	Scientific name	Number caught
No fish caught		0

Haul #:	90	**Latitude:**	46.156 **N**	**Longitude:**	124.334 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/24/1999 2:38:00 AM	**Tow time (minutes):**	36	**Tow distance (km):**	4.25
Speed (km/h):	7.1	**Tow direction (degrees):**	185	**Total caught:**	0

Common name	Scientific name	Number caught
No fish caught		0

Haul #:	91	**Latitude:**	46.141 **N**	**Longitude:**	124.216 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/24/1999 4:46:00 AM	**Tow time (minutes):**	32	**Tow distance (km):**	3.54
Speed (km/h):	6.6	**Tow direction (degrees):**	183	**Total caught:**	78

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	1
California market squid	*Loligo opalescens*	45
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Eulachon	*Thaleichthys pacificus*	6
Pacific hake	*Merluccius productus*	12
Pacific sanddab	*Citharichthys sordidus*	1
Slender sole	*Lyopsetta exilis*	3
Surf smelt	*Hypomesus pretiosus*	9

Haul #:	92	**Latitude:**	46.120 **N**	**Longitude:**	124.156 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	04/24/1999 6:02:00 AM	**Tow time (minutes):**	30	**Tow distance (km):**	3.26
Speed (km/h):	6.5	**Tow direction (degrees):**	353	**Total caught:**	13

Common name	Scientific name	Number caught
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Whitebait smelt	*Allosmerus elongatus*	11
California market squid	*Loligo opalescens*	0
American shad	*Alosa sapidissima*	1

Appendix 1. Continued.

Haul #: 93 **Latitude:** 46.125 **N** **Longitude:** 124.060 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 04/24/1999 8:00:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 2.84
Speed (km/h): 5.7 **Tow direction (degrees):** 331 **Total caught:** 2

Common name	Scientific name	Number caught
Pacific sardine	*Sardinops sagax*	1
American shad	*Alosa sapidissima*	1

Haul #: 94 **Latitude:** 46.693 **N** **Longitude:** 124.183 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/04/1999 9:05:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 3.06
Speed (km/h): 5.9 **Tow direction (degrees):** 174 **Total caught:** 1507

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	6
California market squid	*Loligo opalescens*	79
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	4
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Longfin smelt	*Spirinchus thaleichthys*	62
Northern anchovy	*Engraulis mordax*	1089
Pacific herring	*Clupea pallasi*	13
Sablefish	*Anoplopoma fimbria*	1
Whitebait smelt	*Allosmerus elongatus*	251

Haul #: 95 **Latitude:** 46.657 **N** **Longitude:** 124.295 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/04/1999 10:55:00 PM **Tow time (minutes):** 32 **Tow distance (km):** 3.00
Speed (km/h): 5.6 **Tow direction (degrees):** 174 **Total caught:** 2566

Common name	Scientific name	Number caught
Eulachon	*Thaleichthys pacificus*	1
California market squid	*Loligo opalescens*	115
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Pacific hake	*Merluccius productus*	33
Pacific herring	*Clupea pallasi*	2367
Pacific sanddab	*Citharichthys sordidus*	10
Plainfin midshipman	*Porichthys notatus*	1
Spiny dogfish	*Squalus acanthias*	1
Whitebait smelt	*Allosmerus elongatus*	34
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	2

Appendix 1. Continued.

Haul #:	96	**Latitude:** 46.631 **N**		**Longitude:** 124.399 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/05/1999 2:16:00 AM	**Tow time (minutes):**	31	**Tow distance (km):**	2.65
Speed (km/h):	5.1	**Tow direction (degrees):**	357	**Total caught:**	1773

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	1
Pacific hake	*Merluccius productus*	37
Pacific herring	*Clupea pallasi*	1735

Haul #:	97	**Latitude:** 46.659 **N**		**Longitude:** 124.500 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/05/1999 4:03:00 AM	**Tow time (minutes):**	35	**Tow distance (km):**	3.69
Speed (km/h):	6.3	**Tow direction (degrees):**	189	**Total caught:**	125

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	4
Pacific herring	*Clupea pallasi*	117
California market squid	*Loligo opalescens*	1
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Eulachon	*Thaleichthys pacificus*	1

Haul #:	98	**Latitude:** 46.629 **N**		**Longitude:** 124.612 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/05/1999 5:50:00 AM	**Tow time (minutes):**	32	**Tow distance (km):**	2.86
Speed (km/h):	5.4	**Tow direction (degrees):**	7	**Total caught:**	9

Common name	Scientific name	Number caught
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Pacific herring	*Clupea pallasi*	7
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1

Haul #:	99	**Latitude:** 46.666 **N**		**Longitude:** 124.784 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/05/1999 8:03:00 AM	**Tow time (minutes):**	31	**Tow distance (km):**	3.05
Speed (km/h):	5.9	**Tow direction (degrees):**	177	**Total caught:**	2

Common name	Scientific name	Number caught
Spiny dogfish	*Squalus acanthias*	2

Appendix 1. Continued.

Haul #:	100	**Latitude:**	46.156 **N**	**Longitude:**	124.564 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/05/1999 8:20:00 PM	**Tow time (minutes):**	32	**Tow distance (km):**	2.61
Speed (km/h):	4.9	**Tow direction (degrees):**	183	**Total caught:**	2

Common name	Scientific name	Number caught
Spiny dogfish	*Squalus acanthias*	2

Haul #:	101	**Latitude:**	46.130 **N**	**Longitude:**	124.455 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/05/1999 10:05:00 PM	**Tow time (minutes):**	30	**Tow distance (km):**	2.81
Speed (km/h):	5.6	**Tow direction (degrees):**	2	**Total caught:**	0

Common name	Scientific name	Number caught
No fish caught		0

Haul #:	102	**Latitude:**	46.162 **N**	**Longitude:**	124.339 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/05/1999 11:47:00 PM	**Tow time (minutes):**	31	**Tow distance (km):**	3.50
Speed (km/h):	6.8	**Tow direction (degrees):**	187	**Total caught:**	20

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	1
Pacific hake	*Merluccius productus*	15
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2

Haul #:	103	**Latitude:**	46.140 **N**	**Longitude:**	124.219 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/06/1999 1:31:00 AM	**Tow time (minutes):**	30	**Tow distance (km):**	3.18
Speed (km/h):	6.4	**Tow direction (degrees):**	1	**Total caught:**	204

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	15
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	2
Whitebait smelt	*Allosmerus elongatus*	123
Pacific sanddab	*Citharichthys sordidus*	1
California market squid	*Loligo opalescens*	45
Eulachon	*Thaleichthys pacificus*	6
Pacific hake	*Merluccius productus*	11
Northern anchovy	*Engraulis mordax*	1

Appendix 1. Continued.

Haul #: 104 **Latitude:** 46.168 **N** **Longitude:** 124.156 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/06/1999 2:52:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 3.03
Speed (km/h): 5.9 **Tow direction (degrees):** 179 **Total caught:** 404

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	248
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Northern anchovy	*Engraulis mordax*	1
Pacific herring	*Clupea pallasi*	16
Whitebait smelt	*Allosmerus elongatus*	138

Haul #: 105 **Latitude:** 46.147 **N** **Longitude:** 124.072 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/06/1999 4:22:00 AM **Tow time (minutes):** 33 **Tow distance (km):** 3.46
Speed (km/h): 6.3 **Tow direction (degrees):** 355 **Total caught:** 211

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	142
Pacific herring	*Clupea pallasi*	39
Whitebait smelt	*Allosmerus elongatus*	30

Haul #: 106 **Latitude:** 46.648 **N** **Longitude:** 124.289 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/13/1999 9:44:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 3.29
Speed (km/h): 6.4 **Tow direction (degrees):** 5 **Total caught:** 37

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	3
Whitebait smelt	*Allosmerus elongatus*	2
Pacific sanddab	*Citharichthys sordidus*	4
Pacific herring	*Clupea pallasi*	26
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Coho salmon - adult	*Oncorhynchus kisutch*	1

Haul #: 107 **Latitude:** 46.661 **N** **Longitude:** 124.399 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/13/1999 11:42:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.77
Speed (km/h): 7.5 **Tow direction (degrees):** 182 **Total caught:** 8

Common name	Scientific name	Number caught
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1
Pacific hake	*Merluccius productus*	1
Pacific herring	*Clupea pallasi*	5
Ragfish	*Icosteus aenigmaticus*	1

Appendix 1. Continued.

Haul #:	108	**Latitude:**	46.632 **N**	**Longitude:**	124.511 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/14/1999 1:17:00 AM	**Tow time (minutes):**	34	**Tow distance (km):**	3.45
Speed (km/h):	6.1	**Tow direction (degrees):**	356	**Total caught:**	1

Common name	Scientific name	Number caught
Steelhead	*Oncorhynchus mykiss*	1

Haul #:	109	**Latitude:**	46.660 **N**	**Longitude:**	124.613 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/14/1999 3:00:00 AM	**Tow time (minutes):**	31	**Tow distance (km):**	3.12
Speed (km/h):	6.0	**Tow direction (degrees):**	175	**Total caught:**	0

Common name	Scientific name	Number caught
No fish caught		0

Haul #:	110	**Latitude:**	46.656 **N**	**Longitude:**	124.784 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/14/1999 5:08:00 AM	**Tow time (minutes):**	31	**Tow distance (km):**	3.30
Speed (km/h):	6.4	**Tow direction (degrees):**	178	**Total caught:**	0

Common name	Scientific name	Number caught
No fish caught		0

Haul #:	111	**Latitude:**	46.161 **N**	**Longitude:**	124.570 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/14/1999 9:13:00 PM	**Tow time (minutes):**	30	**Tow distance (km):**	2.85
Speed (km/h):	5.7	**Tow direction (degrees):**	172	**Total caught:**	983

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	983

Haul #:	112	**Latitude:**	46.137 **N**	**Longitude:**	124.456 **W**
Net type:	nordic 264 rope trawl	**Door type:**	foam filled	**Codend liner:**	
Start date/time:	05/14/1999 10:52:00 PM	**Tow time (minutes):**	30	**Tow distance (km):**	3.20
Speed (km/h):	6.4	**Tow direction (degrees):**	358	**Total caught:**	48

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	4
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	1
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	43

Appendix 1. Continued.

Haul #: 113 **Latitude:** 46.167 **N** **Longitude:** 124.334 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/15/1999 12:35:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 3.63
Speed (km/h): 7.0 **Tow direction (degrees):** 173 **Total caught:** 9

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	6
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1
Pacific hake	*Merluccius productus*	1

Haul #: 114 **Latitude:** 46.136 **N** **Longitude:** 124.217 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/15/1999 2:09:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 2.50
Speed (km/h): 4.8 **Tow direction (degrees):** 353 **Total caught:** 66

Common name	Scientific name	Number caught
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1
Whitebait smelt	*Allosmerus elongatus*	1
Pacific sanddab	*Citharichthys sordidus*	2
Pacific herring	*Clupea pallasi*	7
Night smelt	*Spirinchus starksi*	1
California market squid	*Loligo opalescens*	43
Northern anchovy	*Engraulis mordax*	11

Haul #: 115 **Latitude:** 46.155 **N** **Longitude:** 124.158 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/15/1999 3:34:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 3.43
Speed (km/h): 6.6 **Tow direction (degrees):** 174 **Total caught:** 764

Common name	Scientific name	Number caught
Black rockfish	*Sebastes melanops*	1
Whitebait smelt	*Allosmerus elongatus*	181
Pacific herring	*Clupea pallasi*	6
Northern anchovy	*Engraulis mordax*	8
California market squid	*Loligo opalescens*	567
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1

Appendix 1. Continued.

Haul #: 116 **Latitude:** 46.147 **N** **Longitude:** 124.074 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 05/15/1999 5:25:00 AM **Tow time (minutes):** 25 **Tow distance (km):** 2.91
Speed (km/h): 7.0 **Tow direction (degrees):** 170 **Total caught:** 123

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	121
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1

Haul #: 117 **Latitude:** 46.655 **N** **Longitude:** 124.293 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m SK **Codend liner:**
Start date/time: 05/27/1999 8:49:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 4.13
Speed (km/h): 8.0 **Tow direction (degrees):** 184 **Total caught:** 16

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	1
California market squid	*Loligo opalescens*	6
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Pacific herring	*Clupea pallasi*	7
Pacific sanddab	*Citharichthys sordidus*	1

Haul #: 118 **Latitude:** 46.657 **N** **Longitude:** 124.401 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m SK **Codend liner:**
Start date/time: 05/27/1999 10:53:00 PM **Tow time (minutes):** 32 **Tow distance (km):** 4.74
Speed (km/h): 8.9 **Tow direction (degrees):** 181 **Total caught:** 10

Common name	Scientific name	Number caught
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Pacific hake	*Merluccius productus*	1
Pacific herring	*Clupea pallasi*	7

Haul #: 119 **Latitude:** 46.661 **N** **Longitude:** 124.509 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m SK **Codend liner:**
Start date/time: 05/28/1999 1:08:00 AM **Tow time (minutes):** 32 **Tow distance (km):** 4.06
Speed (km/h): 7.6 **Tow direction (degrees):** 181 **Total caught:** 3

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	1
Pacific herring	*Clupea pallasi*	2

Appendix 1. Continued.

Haul #:	120	**Latitude:**	46.652 **N**	**Longitude:**	124.602 **W**
Net type:	nordic 264 rope trawl	**Door type:**	3 m SK	**Codend liner:**	
Start date/time:	05/28/1999 3:16:00 AM	**Tow time (minutes):**	31	**Tow distance (km):**	4.05
Speed (km/h):	7.8	**Tow direction (degrees):**	185	**Total caught:**	15

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	4
Pacific herring	*Clupea pallasi*	11

Haul #:	121	**Latitude:**	46.675 **N**	**Longitude:**	124.785 **W**
Net type:	nordic 264 rope trawl	**Door type:**	3 m SK	**Codend liner:**	
Start date/time:	05/28/1999 5:46:00 AM	**Tow time (minutes):**	32	**Tow distance (km):**	4.13
Speed (km/h):	7.8	**Tow direction (degrees):**	192	**Total caught:**	0

Common name	Scientific name	Number caught
No fish caught		0

Haul #:	122	**Latitude:**	46.157 **N**	**Longitude:**	124.571 **W**
Net type:	nordic 264 rope trawl	**Door type:**	3 m SK	**Codend liner:**	
Start date/time:	05/28/1999 7:20:00 PM	**Tow time (minutes):**	30	**Tow distance (km):**	4.54
Speed (km/h):	9.1	**Tow direction (degrees):**	176	**Total caught:**	45

Common name	Scientific name	Number caught
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1
Jack mackerel	*Trachurus symmetricus*	43
Pacific hake	*Merluccius productus*	1

Haul #:	123	**Latitude:**	46.163 **N**	**Longitude:**	124.456 **W**
Net type:	nordic 264 rope trawl	**Door type:**	3m SK	**Codend liner:**	
Start date/time:	05/28/1999 9:38:00 PM	**Tow time (minutes):**	30	**Tow distance (km):**	3.94
Speed (km/h):	7.9	**Tow direction (degrees):**	180	**Total caught:**	1

Common name	Scientific name	Number caught
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1

Haul #:	124	**Latitude:**	46.160 **N**	**Longitude:**	124.332 **W**
Net type:	nordic 264 rope trawl	**Door type:**	3 m SK	**Codend liner:**	
Start date/time:	05/28/1999 11:48:00 PM	**Tow time (minutes):**	30	**Tow distance (km):**	4.15
Speed (km/h):	8.3	**Tow direction (degrees):**	189	**Total caught:**	3

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	3

Appendix 1. Continued.

Haul #:	125	**Latitude:** 46.155 **N**		**Longitude:** 124.222 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	3 m SK	**Codend liner:**	
Start date/time:	05/29/1999 1:49:00 AM	**Tow time (minutes):**	30	**Tow distance (km):**	3.98
Speed (km/h):	8.0	**Tow direction (degrees):**	188	**Total caught:**	0

Common name	Scientific name	Number caught
No fish caught		0

Haul #:	126	**Latitude:** 46.156 **N**		**Longitude:** 124.162 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	3 m SK	**Codend liner:**	
Start date/time:	05/29/1999 3:43:00 AM	**Tow time (minutes):**	31	**Tow distance (km):**	3.63
Speed (km/h):	7.0	**Tow direction (degrees):**	200	**Total caught:**	30

Common name	Scientific name	Number caught
Northern anchovy	*Engraulis mordax*	1
Whitebait smelt	*Allosmerus elongatus*	10
Pacific staghorn sculpin	*Leptocottus armatus*	1
Pacific sanddab	*Citharichthys sordidus*	11
Pacific hake	*Merluccius productus*	6
Pacific herring	*Clupea pallasi*	1

Haul #:	127	**Latitude:** 46.161 **N**		**Longitude:** 124.074 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	3 m SK	**Codend liner:**	
Start date/time:	05/29/1999 5:46:00 AM	**Tow time (minutes):**	27	**Tow distance (km):**	3.53
Speed (km/h):	7.8	**Tow direction (degrees):**	178	**Total caught:**	0

Common name	Scientific name	Number caught
No fish caught		0

Haul #:	128	**Latitude:** 46.673 **N**		**Longitude:** 124.182 **W**	
Net type:	nordic 264 rope trawl	**Door type:**	3 m foam filled	**Codend liner:**	
Start date/time:	06/12/1999 7:36:00 PM	**Tow time (minutes):**	32	**Tow distance (km):**	2.62
Speed (km/h):	4.9	**Tow direction (degrees):**	201	**Total caught:**	32

Common name	Scientific name	Number caught
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	4
Skates	*Rajidae*	1
Starry flounder	*Platichthys stellatus*	27

Appendix 1. Continued.

Haul #: 129 **Latitude:** 46.654 **N** **Longitude:** 124.295 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/12/1999 9:19:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.09
Speed (km/h): 6.2 **Tow direction (degrees):** 8 **Total caught:** 28

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	1
Thresher shark	*Alopias vulpinus*	1
Spiny dogfish	*Squalus acanthias*	4
American shad	*Alosa sapidissima*	1
Pacific sanddab	*Citharichthys sordidus*	9
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	8
Pacific hake	*Merluccius productus*	2

Haul #: 130 **Latitude:** 46.673 **N** **Longitude:** 124.399 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/12/1999 11:13:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.45
Speed (km/h): 6.9 **Tow direction (degrees):** 175 **Total caught:** 48

Common name	Scientific name	Number caught
Jack mackerel	*Trachurus symmetricus*	27
Pacific sardine	*Sardinops sagax*	5
Pacific sanddab	*Citharichthys sordidus*	1
Pacific hake	*Merluccius productus*	4
Spiny dogfish	*Squalus acanthias*	1
Chub mackerel	*Scomber japonicus*	6
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1
American shad	*Alosa sapidissima*	1
Pacific herring	*Clupea pallasi*	2

Haul #: 131 **Latitude:** 46.642 **N** **Longitude:** 124.508 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/13/1999 12:53:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 2.53
Speed (km/h): 5.1 **Tow direction (degrees):** 359 **Total caught:** 362

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	34
Pacific sardine	*Sardinops sagax*	73
Pacific herring	*Clupea pallasi*	3
Jack mackerel	*Trachurus symmetricus*	133
American shad	*Alosa sapidissima*	3
Chub mackerel	*Scomber japonicus*	116

Appendix 1. Continued.

Haul #: 132 **Latitude:** 46.676 **N** **Longitude:** 124.605 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/13/1999 2:39:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.17
Speed (km/h): 6.3 **Tow direction (degrees):** 177 **Total caught:** 103

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	101
Pacific sardine	*Sardinops sagax*	1
Unidentified bony fish	*Osteichthyes*	1

Haul #: 133 **Latitude:** 46.653 **N** **Longitude:** 124.787 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/13/1999 4:53:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 2.63
Speed (km/h): 5.3 **Tow direction (degrees):** 1 **Total caught:** 4

Common name	Scientific name	Number caught
Jack mackerel	*Trachurus symmetricus*	3
Spiny dogfish	*Squalus acanthias*	1

Haul #: 134 **Latitude:** 46.157 **N** **Longitude:** 124.572 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/13/1999 10:02:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.25
Speed (km/h): 6.5 **Tow direction (degrees):** 186 **Total caught:** 89

Common name	Scientific name	Number caught
Pacific sardine	*Sardinops sagax*	1
Pacific hake	*Merluccius productus*	41
Jack mackerel	*Trachurus symmetricus*	47

Haul #: 135 **Latitude:** 46.141 **N** **Longitude:** 124.457 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/13/1999 11:51:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 2.75
Speed (km/h): 5.3 **Tow direction (degrees):** 359 **Total caught:** 340

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	228
Pacific sardine	*Sardinops sagax*	110
Spiny dogfish	*Squalus acanthias*	1
Jack mackerel	*Trachurus symmetricus*	1

Appendix 1. Continued.

Haul #: 136 **Latitude:** 46.168 **N** **Longitude:** 124.335 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/14/1999 1:42:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 2.98
Speed (km/h): 5.8 **Tow direction (degrees):** 182 **Total caught:** 129

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	26
Jack mackerel	*Trachurus symmetricus*	2
Pacific hake	*Merluccius productus*	56
Pacific sardine	*Sardinops sagax*	44
Wolf-eel	*Anarrhichthys ocellatus*	1

Haul #: 137 **Latitude:** 46.161 **N** **Longitude:** 124.222 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/14/1999 3:27:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 2.95
Speed (km/h): 5.9 **Tow direction (degrees):** 349 **Total caught:** 0

Common name	Scientific name	Number caught
No fish caught		0

Haul #: 138 **Latitude:** 46.164 **N** **Longitude:** 124.158 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 06/14/1999 5:05:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 2.91
Speed (km/h): 5.8 **Tow direction (degrees):** 180 **Total caught:** 16

Common name	Scientific name	Number caught
Coho salmon - juvenile	*Oncorhynchus kisutch*	14
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2

Haul #: 139 **Latitude:** 46.165 **N** **Longitude:** 124.075 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 06/14/1999 6:37:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 2.83
Speed (km/h): 5.5 **Tow direction (degrees):** 357 **Total caught:** 13

Common name	Scientific name	Number caught
Starry flounder	*Platichthys stellatus*	1
Pacific herring	*Clupea pallasi*	1
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Coho salmon - juvenile	*Oncorhynchus kisutch*	9

Appendix 1. Continued.

Haul #: 140 **Latitude:** 46.665 **N** **Longitude:** 124.179 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/25/1999 8:25:00 PM **Tow time (minutes):** 25 **Tow distance (km):** 2.67
Speed (km/h): 6.4 **Tow direction (degrees):** 169 **Total caught:** 22

Common name	Scientific name	Number caught
California market squid	*Loligo opalescens*	9
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	5
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Pacific sand lance	*Ammodytes hexapterus*	4
Wolf-eel	*Anarrhichthys ocellatus*	1

Haul #: 141 **Latitude:** 46.664 **N** **Longitude:** 124.292 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/25/1999 10:10:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 2.74
Speed (km/h): 5.5 **Tow direction (degrees):** 176 **Total caught:** 76

Common name	Scientific name	Number caught
Jack mackerel	*Trachurus symmetricus*	38
Spiny dogfish	*Squalus acanthias*	2
Pacific herring	*Clupea pallasi*	3
Chub mackerel	*Scomber japonicus*	1
California market squid	*Loligo opalescens*	6
Coho salmon - adult	*Oncorhynchus kisutch*	1
Pacific sardine	*Sardinops sagax*	25

Haul #: 142 **Latitude:** 46.659 **N** **Longitude:** 124.404 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/25/1999 11:51:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.22
Speed (km/h): 6.4 **Tow direction (degrees):** 185 **Total caught:** 210

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	1
Spiny dogfish	*Squalus acanthias*	2
Soupfin shark	*Galeorhinus zyopterus*	2
Pacific herring	*Clupea pallasi*	2
Jack mackerel	*Trachurus symmetricus*	97
Chub mackerel	*Scomber japonicus*	22
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
American shad	*Alosa sapidissima*	13
Pacific sardine	*Sardinops sagax*	70

Appendix 1. Continued.

Haul #: 143 **Latitude:** 46.660 **N** **Longitude:** 124.510 **W**
Net type: nordic 264 rope trawl **Door type:** 3 M foam filled **Codend liner:**
Start date/time: 06/26/1999 1:41:00 AM **Tow time (minutes):** 29 **Tow distance (km):** 3.16
Speed (km/h): 6.5 **Tow direction (degrees):** 183 **Total caught:** 317

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	5
Pacific herring	*Clupea pallasi*	110
Spiny dogfish	*Squalus acanthias*	1
Soupfin shark	*Galeorhinus zyopterus*	3
Pacific sardine	*Sardinops sagax*	113
Pacific hake	*Merluccius productus*	39
Jack mackerel	*Trachurus symmetricus*	23
Blue shark	*Prionace glauca*	1
Chub mackerel	*Scomber japonicus*	22

Haul #: 144 **Latitude:** 46.661 **N** **Longitude:** 124.610 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/26/1999 3:20:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.22
Speed (km/h): 6.4 **Tow direction (degrees):** 180 **Total caught:** 123

Common name	Scientific name	Number caught
Pacific sardine	*Sardinops sagax*	39
American shad	*Alosa sapidissima*	3
Chub mackerel	*Scomber japonicus*	7
Jack mackerel	*Trachurus symmetricus*	45
Pacific herring	*Clupea pallasi*	29

Haul #: 145 **Latitude:** 46.660 **N** **Longitude:** 124.785 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/26/1999 5:10:00 AM **Tow time (minutes):** 39 **Tow distance (km):** 3.34
Speed (km/h): 5.1 **Tow direction (degrees):** 181 **Total caught:** 16

Common name	Scientific name	Number caught
Unidentified bony fish	*Osteichthyes*	4
Black rockfish	*Sebastes melanops*	8
Pacific sardine	*Sardinops sagax*	4

Appendix 1. Continued.

Haul #: 146 **Latitude:** 46.156 **N** **Longitude:** 124.571 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/26/1999 8:15:00 PM **Tow time (minutes):** 29 **Tow distance (km):** 3.28
Speed (km/h): 6.8 **Tow direction (degrees):** 183 **Total caught:** 259

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	10
Coho salmon - juvenile	*Oncorhynchus kisutch*	2
Jack mackerel	*Trachurus symmetricus*	247

Haul #: 147 **Latitude:** 46.158 **N** **Longitude:** 124.459 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/26/1999 10:10:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 2.99
Speed (km/h): 6.0 **Tow direction (degrees):** 204 **Total caught:** 349

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	8
Chub mackerel	*Scomber japonicus*	50
Jack mackerel	*Trachurus symmetricus*	208
Pacific hake	*Merluccius productus*	12
Pacific herring	*Clupea pallasi*	13
Pacific sardine	*Sardinops sagax*	57
Spiny dogfish	*Squalus acanthias*	1

Haul #: 148 **Latitude:** 46.161 **N** **Longitude:** 124.337 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/27/1999 12:15:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.10
Speed (km/h): 6.2 **Tow direction (degrees):** 202 **Total caught:** 68

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	3
Spiny dogfish	*Squalus acanthias*	1
Pacific hake	*Merluccius productus*	1
Pacific sardine	*Sardinops sagax*	63

Haul #: 149 **Latitude:** 46.156 **N** **Longitude:** 124.220 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/27/1999 2:22:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.07
Speed (km/h): 6.1 **Tow direction (degrees):** 198 **Total caught:** 141

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	3
Eulachon	*Thaleichthys pacificus*	2
Pacific herring	*Clupea pallasi*	2
Pacific sardine	*Sardinops sagax*	134

Appendix 1. Continued.

Haul #: 150 **Latitude:** 46.158 **N** **Longitude:** 124.156 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/27/1999 4:10:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.10
Speed (km/h): 6.2 **Tow direction (degrees):** 188 **Total caught:** 16

Common name	Scientific name	Number caught
Wolf-eel	*Anarrhichthys ocellatus*	1
California market squid	*Loligo opalescens*	7
Night smelt	*Spirinchus starksi*	1
Pacific herring	*Clupea pallasi*	1
Pacific sardine	*Sardinops sagax*	6

Haul #: 151 **Latitude:** 46.160 **N** **Longitude:** 124.072 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled - net **Codend liner:**
Start date/time: 06/27/1999 5:51:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.01
Speed (km/h): 6.0 **Tow direction (degrees):** 177 **Total caught:** 6

Common name	Scientific name	Number caught
Wolf-eel	*Anarrhichthys ocellatus*	2
Pacific herring	*Clupea pallasi*	1
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Night smelt	*Spirinchus starksi*	1

Haul #: 152 **Latitude:** 46.675 **N** **Longitude:** 124.180 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/06/1999 8:25:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 3.04
Speed (km/h): 5.9 **Tow direction (degrees):** 165 **Total caught:** 404

Common name	Scientific name	Number caught
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Wolf-eel	*Anarrhichthys ocellatus*	1
Starry flounder	*Platichthys stellatus*	1
Spiny dogfish	*Squalus acanthias*	2
Northern anchovy	*Engraulis mordax*	88
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	9
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	2
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	279
American shad	*Alosa sapidissima*	3
Pacific herring	*Clupea pallasi*	18

Appendix 1. Continued.

Haul #: 153 **Latitude:** 46.658 **N** **Longitude:** 124.293 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/06/1999 10:20:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.18
Speed (km/h): 6.4 **Tow direction (degrees):** 181 **Total caught:** 159

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	1
Pacific sardine	*Sardinops sagax*	76
Wolf-eel	*Anarrhichthys ocellatus*	1
Spiny dogfish	*Squalus acanthias*	2
Pacific herring	*Clupea pallasi*	1
Northern anchovy	*Engraulis mordax*	6
Eulachon	*Thaleichthys pacificus*	8
Pacific sanddab	*Citharichthys sordidus*	64

Haul #: 154 **Latitude:** 46.658 **N** **Longitude:** 124.397 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/07/1999 12:04:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.05
Speed (km/h): 6.1 **Tow direction (degrees):** 168 **Total caught:** 17

Common name	Scientific name	Number caught
Rex sole	*Errex zachirus*	1
Eulachon	*Thaleichthys pacificus*	4
Jack mackerel	*Trachurus symmetricus*	1
Pacific hake	*Merluccius productus*	8
Pacific herring	*Clupea pallasi*	1
Pacific sardine	*Sardinops sagax*	2

Haul #: 155 **Latitude:** 46.656 **N** **Longitude:** 124.507 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/07/1999 2:00:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.61
Speed (km/h): 7.2 **Tow direction (degrees):** 172 **Total caught:** 820

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	8
Soupfin shark	*Galeorhinus zyopterus*	1
River lamprey	*Lampetra ayresii*	1
Pacific sardine	*Sardinops sagax*	529
Pacific lamprey	*Lampetra tridentata*	1
Jack mackerel	*Trachurus symmetricus*	175
Eulachon	*Thaleichthys pacificus*	1
American shad	*Alosa sapidissima*	1
Chub mackerel	*Scomber japonicus*	89
Pacific hake	*Merluccius productus*	14

Appendix 1. Continued.

Haul #: 156 **Latitude:** 46.656 **N** **Longitude:** 124.597 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/07/1999 3:58:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.15
Speed (km/h): 6.3 **Tow direction (degrees):** 174 **Total caught:** 22

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	2
Jack mackerel	*Trachurus symmetricus*	4
Pacific sardine	*Sardinops sagax*	16

Haul #: 157 **Latitude:** 46.656 **N** **Longitude:** 124.780 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/07/1999 6:14:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.22
Speed (km/h): 6.4 **Tow direction (degrees):** 178 **Total caught:** 45

Common name	Scientific name	Number caught
Rockfishes	*Sebastes*	15
Thresher shark	*Alopias vulpinus*	1
Blue shark	*Prionace glauca*	2
Black rockfish	*Sebastes melanops*	27

Haul #: 158 **Latitude:** 46.164 **N** **Longitude:** 124.569 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/07/1999 8:17:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.41
Speed (km/h): 6.8 **Tow direction (degrees):** 178 **Total caught:** 38

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	1
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Jack mackerel	*Trachurus symmetricus*	17
Pacific sardine	*Sardinops sagax*	16
Sablefish	*Anoplopoma fimbria*	1
Wolf-eel	*Anarrhichthys ocellatus*	1
Blue shark	*Prionace glauca*	1

Haul #: 159 **Latitude:** 46.159 **N** **Longitude:** 124.452 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/07/1999 10:01:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.49
Speed (km/h): 7.0 **Tow direction (degrees):** 183 **Total caught:** 40

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	39
Wolf-eel	*Anarrhichthys ocellatus*	1

Appendix 1. Continued.

Haul #: 160 **Latitude:** 46.162 **N** **Longitude:** 124.344 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/07/1999 11:51:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.39
Speed (km/h): 6.8 **Tow direction (degrees):** 201 **Total caught:** 7

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	3
Spiny dogfish	*Squalus acanthias*	2
Pacific herring	*Clupea pallasi*	1
Pacific hake	*Merluccius productus*	1

Haul #: 161 **Latitude:** 46.159 **N** **Longitude:** 124.225 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/08/1999 2:04:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 2.95
Speed (km/h): 5.9 **Tow direction (degrees):** 193 **Total caught:** 2

Common name	Scientific name	Number caught
Pacific tomcod	*Microgadus proximus*	2

Haul #: 162 **Latitude:** 46.160 **N** **Longitude:** 124.156 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/08/1999 3:40:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.23
Speed (km/h): 6.5 **Tow direction (degrees):** 150 **Total caught:** 4

Common name	Scientific name	Number caught
Night smelt	*Spirinchus starksi*	1
Pacific herring	*Clupea pallasi*	1
Pacific staghorn sculpin	*Leptocottus armatus*	2

Haul #: 163 **Latitude:** 46.178 **N** **Longitude:** 124.075 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/08/1999 5:13:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.01
Speed (km/h): 6.0 **Tow direction (degrees):** 343 **Total caught:** 10

Common name	Scientific name	Number caught
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Whitebait smelt	*Allosmerus elongatus*	1
Smelts	*Osmeridae*	0
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	5
Big skate	*Raja binoculata*	1
Starry flounder	*Platichthys stellatus*	1

Appendix 1. Continued.

Haul #: 164 **Latitude:** 46.653 **N** **Longitude:** 124.175 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/13/1999 8:28:00 PM **Tow time (minutes):** 33 **Tow distance (km):** 3.32
Speed (km/h): 6.0 **Tow direction (degrees):** 163 **Total caught:** 1157

Common name	Scientific name	Number caught
Black rockfish	*Sebastes melanops*	5
Northern anchovy	*Engraulis mordax*	4
Spiny dogfish	*Squalus acanthias*	12
Rex sole	*Errex zachirus*	1
Plainfin midshipman	*Porichthys notatus*	28
Pacific tomcod	*Microgadus proximus*	966
Pacific herring	*Clupea pallasi*	88
Eulachon	*Thaleichthys pacificus*	1
English sole	*Pleuronectes vetulus*	8
Butter sole	*Pleuronectes isolepis*	9
Starry flounder	*Platichthys stellatus*	19
Big skate	*Raja binoculata*	12
American shad	*Alosa sapidissima*	1
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	3

Haul #: 165 **Latitude:** 46.658 **N** **Longitude:** 124.290 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/13/1999 10:32:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 3.44
Speed (km/h): 6.7 **Tow direction (degrees):** 171 **Total caught:** 440

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	78
Pacific sardine	*Sardinops sagax*	85
Spiny dogfish	*Squalus acanthias*	65
Pacific sanddab	*Citharichthys sordidus*	1
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
American shad	*Alosa sapidissima*	65
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	2
Northern anchovy	*Engraulis mordax*	143

Appendix 1. Continued.

Haul #: 166 **Latitude:** 46.653 **N** **Longitude:** 124.400 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/14/1999 12:30:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.69
Speed (km/h): 7.4 **Tow direction (degrees):** 181 **Total caught:** 129

Common name	Scientific name	Number caught
Pacific sardine	*Sardinops sagax*	80
Spiny dogfish	*Squalus acanthias*	4
Pacific herring	*Clupea pallasi*	6
Pacific hake	*Merluccius productus*	8
Jack mackerel	*Trachurus symmetricus*	9
Chub mackerel	*Scomber japonicus*	1
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	2
American shad	*Alosa sapidissima*	19

Haul #: 167 **Latitude:** 46.639 **N** **Longitude:** 124.499 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/14/1999 2:51:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 3.46
Speed (km/h): 6.7 **Tow direction (degrees):** 157 **Total caught:** 64

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	3
Jack mackerel	*Trachurus symmetricus*	6
Pacific hake	*Merluccius productus*	6
Pacific herring	*Clupea pallasi*	7
Pacific sardine	*Sardinops sagax*	33
American shad	*Alosa sapidissima*	9

Haul #: 168 **Latitude:** 46.131 **N** **Longitude:** 124.546 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/14/1999 8:25:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 2.14
Speed (km/h): 4.2 **Tow direction (degrees):** 333 **Total caught:** 25

Common name	Scientific name	Number caught
Blue shark	*Prionace glauca*	1
California market squid	*Loligo opalescens*	3
Pacific hake	*Merluccius productus*	21

Appendix 1. Continued.

Haul #: 169 **Latitude:** 46.159 **N** **Longitude:** 124.453 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/14/1999 10:02:00 PM **Tow time (minutes):** 29 **Tow distance (km):** 3.32
Speed (km/h): 6.9 **Tow direction (degrees):** 178 **Total caught:** 245

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	14
Pacific sardine	*Sardinops sagax*	150
Chub mackerel	*Scomber japonicus*	62
Jack mackerel	*Trachurus symmetricus*	19

Haul #: 170 **Latitude:** 46.164 **N** **Longitude:** 124.341 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/14/1999 11:53:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 3.06
Speed (km/h): 6.1 **Tow direction (degrees):** 191 **Total caught:** 5

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	2
Pacific sardine	*Sardinops sagax*	2
California market squid	*Loligo opalescens*	1

Haul #: 171 **Latitude:** 46.159 **N** **Longitude:** 124.216 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/15/1999 1:52:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 3.06
Speed (km/h): 6.1 **Tow direction (degrees):** 209 **Total caught:** 110

Common name	Scientific name	Number caught
American shad	*Alosa sapidissima*	1
Pacific hake	*Merluccius productus*	54
Pacific lamprey	*Lampetra tridentata*	1
Pacific sanddab	*Citharichthys sordidus*	51
Pacific staghorn sculpin	*Leptocottus armatus*	1
Whitebait smelt	*Allosmerus elongatus*	1
Wolf-eel	*Anarrhichthys ocellatus*	1

Appendix 1. Continued.

Haul #: 172 **Latitude:** 46.138 **N** **Longitude:** 124.154 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/15/1999 3:13:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 2.86
Speed (km/h): 5.7 **Tow direction (degrees):** 3 **Total caught:** 86

Common name	Scientific name	Number caught
Northern anchovy	*Engraulis mordax*	1
Whitebait smelt	*Allosmerus elongatus*	26
Pacific sanddab	*Citharichthys sordidus*	19
American shad	*Alosa sapidissima*	32
California market squid	*Loligo opalescens*	2
Pacific hake	*Merluccius productus*	1
Pacific herring	*Clupea pallasi*	5

Haul #: 173 **Latitude:** 46.177 **N** **Longitude:** 124.075 **W**
Net type: nordic 264 rope trawl **Door type:** 3 m foam filled **Codend liner:**
Start date/time: 07/15/1999 4:34:00 AM **Tow time (minutes):** 32 **Tow distance (km):** 3.23
Speed (km/h): 6.1 **Tow direction (degrees):** 176 **Total caught:** 42

Common name	Scientific name	Number caught
Whitebait smelt	*Allosmerus elongatus*	6
American shad	*Alosa sapidissima*	4
Pacific herring	*Clupea pallasi*	6
Pacific tomcod	*Microgadus proximus*	26

Haul #: 174 **Latitude:** 46.675 **N** **Longitude:** 124.184 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/27/1999 8:21:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 2.91
Speed (km/h): 5.8 **Tow direction (degrees):** 177 **Total caught:** 93

Common name	Scientific name	Number caught
Starry flounder	*Platichthys stellatus*	45
Spiny dogfish	*Squalus acanthias*	13
Pacific herring	*Clupea pallasi*	34
Pacific tomcod	*Microgadus proximus*	1

Appendix 1. Continued.

Haul #: 175 **Latitude:** 46.644 **N** **Longitude:** 124.304 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/27/1999 10:08:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 2.75
Speed (km/h): 5.5 **Tow direction (degrees):** 4 **Total caught:** 5466

Common name	Scientific name	Number caught
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	1
Spiny dogfish	*Squalus acanthias*	5
Pacific sardine	*Sardinops sagax*	5065
Pacific sanddab	*Citharichthys sordidus*	13
Pacific hake	*Merluccius productus*	331
Chub mackerel	*Scomber japonicus*	8
Jack mackerel	*Trachurus symmetricus*	22
Pacific herring	*Clupea pallasi*	21

Haul #: 176 **Latitude:** 46.662 **N** **Longitude:** 124.410 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/28/1999 **Tow time (minutes):** 31 **Tow distance (km):** 3.51
Speed (km/h): 6.8 **Tow direction (degrees):** 178 **Total caught:** 543

Common name	Scientific name	Number caught
Sablefish	*Anoplopoma fimbria*	1
Spiny dogfish	*Squalus acanthias*	2
Pacific sardine	*Sardinops sagax*	123
Pacific herring	*Clupea pallasi*	197
Jack mackerel	*Trachurus symmetricus*	176
Chub mackerel	*Scomber japonicus*	34
California market squid	*Loligo opalescens*	1
American shad	*Alosa sapidissima*	2
Pacific hake	*Merluccius productus*	6
Yellowtail rockfish	*Sebastes flavidus*	1

Appendix 1. Continued.

Haul #: 177 **Latitude:** 46.636 **N** **Longitude:** 124.520 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/28/1999 1:43:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 2.40
Speed (km/h): 4.8 **Tow direction (degrees):** 1 **Total caught:** 241

Common name	Scientific name	Number caught
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	1
Spiny dogfish	*Squalus acanthias*	1
Pacific sardine	*Sardinops sagax*	37
Pacific herring	*Clupea pallasi*	93
Pacific hake	*Merluccius productus*	11
Chub mackerel	*Scomber japonicus*	23
American shad	*Alosa sapidissima*	1
Jack mackerel	*Trachurus symmetricus*	74

Haul #: 178 **Latitude:** 46.674 **N** **Longitude:** 124.607 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/28/1999 3:26:00 AM **Tow time (minutes):** 32 **Tow distance (km):** 3.22
Speed (km/h): 6.0 **Tow direction (degrees):** 181 **Total caught:** 1073

Common name	Scientific name	Number caught
Eulachon	*Thaleichthys pacificus*	1
Pacific herring	*Clupea pallasi*	442
Pacific sardine	*Sardinops sagax*	392
Chub mackerel	*Scomber japonicus*	58
Pacific hake	*Merluccius productus*	72
Jack mackerel	*Trachurus symmetricus*	108

Haul #: 179 **Latitude:** 46.673 **N** **Longitude:** 124.793 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/28/1999 5:40:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 3.28
Speed (km/h): 6.4 **Tow direction (degrees):** 174 **Total caught:** 103

Common name	Scientific name	Number caught
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	1
Chub mackerel	*Scomber japonicus*	1
Chum salmon - juvenile	*Oncorhynchus keta*	1
Jack mackerel	*Trachurus symmetricus*	7
Pacific herring	*Clupea pallasi*	75
Pacific sardine	*Sardinops sagax*	18

Appendix 1. Continued.

Haul #: 180 **Latitude:** 46.162 **N** **Longitude:** 124.562 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/28/1999 8:24:00 PM **Tow time (minutes):** 31 **Tow distance (km):** 3.23
Speed (km/h): 6.3 **Tow direction (degrees):** 178 **Total caught:** 320

Common name	Scientific name	Number caught
Chub mackerel	*Scomber japonicus*	7
Jack mackerel	*Trachurus symmetricus*	313

Haul #: 181 **Latitude:** 46.146 **N** **Longitude:** 124.443 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/28/1999 10:04:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 2.67
Speed (km/h): 5.3 **Tow direction (degrees):** 6 **Total caught:** 539

Common name	Scientific name	Number caught
Pacific herring	*Clupea pallasi*	1
Pacific sardine	*Sardinops sagax*	438
Pacific hake	*Merluccius productus*	1
American shad	*Alosa sapidissima*	1
Chub mackerel	*Scomber japonicus*	26
Jack mackerel	*Trachurus symmetricus*	72

Haul #: 182 **Latitude:** 46.171 **N** **Longitude:** 124.334 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/28/1999 11:40:00 PM **Tow time (minutes):** 30 **Tow distance (km):** 2.79
Speed (km/h): 5.6 **Tow direction (degrees):** 201 **Total caught:** 2341

Common name	Scientific name	Number caught
Pacific hake	*Merluccius productus*	7
American shad	*Alosa sapidissima*	4
Pacific herring	*Clupea pallasi*	8
Jack mackerel	*Trachurus symmetricus*	30
Chub mackerel	*Scomber japonicus*	43
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Chinook salmon - ocean fish	*Oncorhynchus tshawytscha*	3
Pacific sardine	*Sardinops sagax*	2244

Appendix 1. Continued.

Haul #: 183 **Latitude:** 46.160 **N** **Longitude:** 124.206 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/29/1999 1:57:00 AM **Tow time (minutes):** 31 **Tow distance (km):** 2.83
Speed (km/h): 5.5 **Tow direction (degrees):** 175 **Total caught:** 400

Common name	Scientific name	Number caught
Pacific sanddab	*Citharichthys sordidus*	21
Whitebait smelt	*Allosmerus elongatus*	1
Black rockfish	*Sebastes melanops*	1
Starry flounder	*Platichthys stellatus*	1
Wolf-eel	*Anarrhichthys ocellatus*	1
Spiny dogfish	*Squalus acanthias*	1
Pacific sardine	*Sardinops sagax*	71
Pacific herring	*Clupea pallasi*	280
Pacific hake	*Merluccius productus*	5
Eulachon	*Thaleichthys pacificus*	3
California market squid	*Loligo opalescens*	1
American shad	*Alosa sapidissima*	11
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1
Pacific lamprey	*Lampetra tridentata*	2

Haul #: 184 **Latitude:** 46.151 **N** **Longitude:** 124.151 **W**
Net type: nordic 264 rope trawl **Door type:** foam filled **Codend liner:**
Start date/time: 07/29/1999 3:18:00 AM **Tow time (minutes):** 30 **Tow distance (km):** 2.66
Speed (km/h): 5.3 **Tow direction (degrees):** 347 **Total caught:** 344

Common name	Scientific name	Number caught
Pacific sanddab	*Citharichthys sordidus*	10
Pacific sardine	*Sardinops sagax*	326
Pacific herring	*Clupea pallasi*	6
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	1
American shad	*Alosa sapidissima*	1

Appendix 1. Continued.

Haul #: 185
Net type: nordic 264 rope trawl
Start date/time: 07/29/1999 5:04:00 AM
Speed (km/h): 5.6

Latitude: 46.175 **N**
Door type: foam filled
Tow time (minutes): 34
Tow direction (degrees): 168

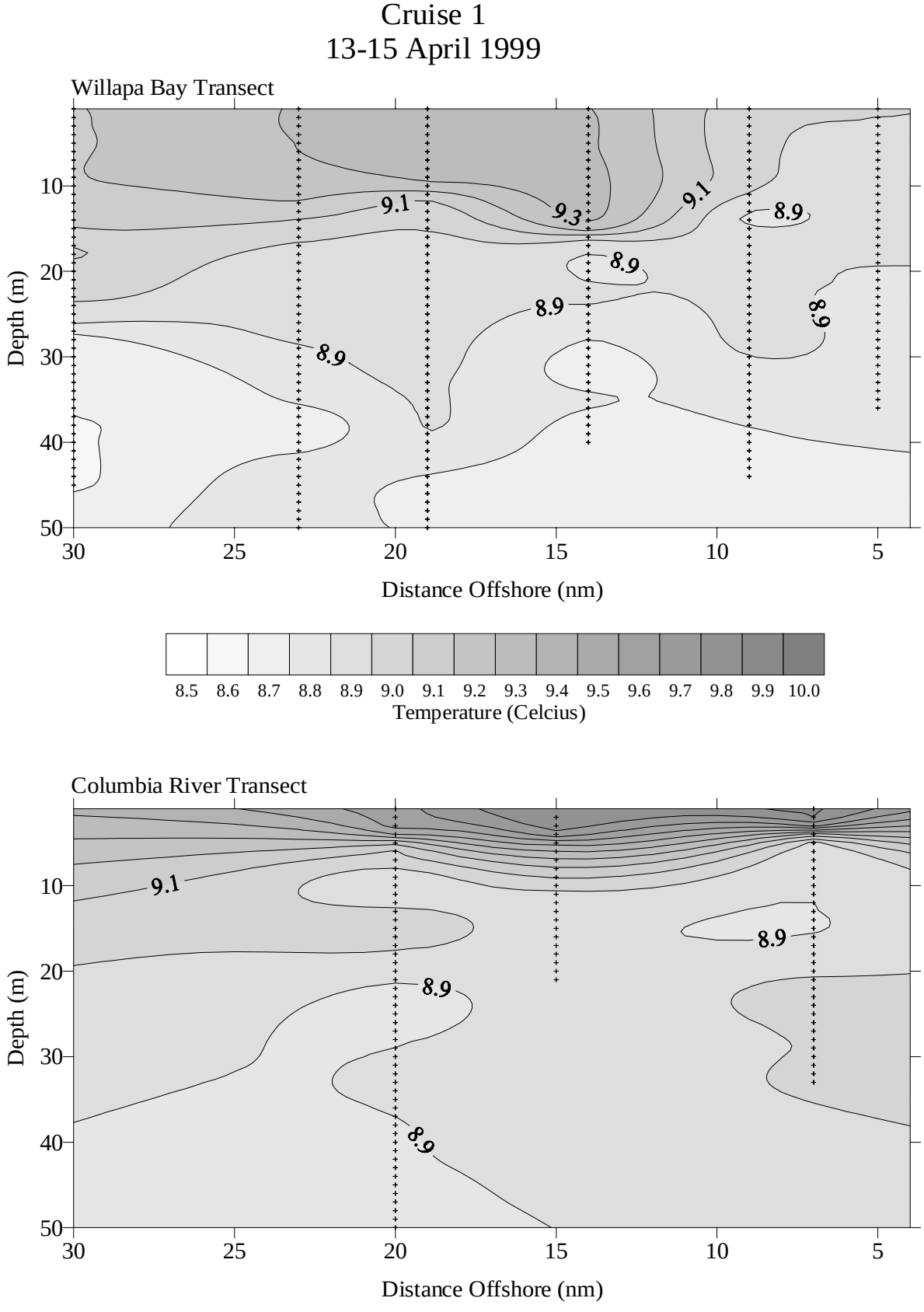
Longitude: 124.065 **W**
Codend liner:
Tow distance (km): 3.18
Total caught: 73

Common name	Scientific name	Number caught
Starry flounder	*Platichthys stellatus*	1
California market squid	*Loligo opalescens*	2
Chinook salmon - 0 age	*Oncorhynchus tshawytscha*	2
Chinook salmon - yearling	*Oncorhynchus tshawytscha*	2
Coho salmon - juvenile	*Oncorhynchus kisutch*	1
Pacific herring	*Clupea pallasi*	55
Pacific sardine	*Sardinops sagax*	6
Pacific tomcod	*Microgadus proximus*	1
Spiny dogfish	*Squalus acanthias*	1
American shad	*Alosa sapidissima*	2

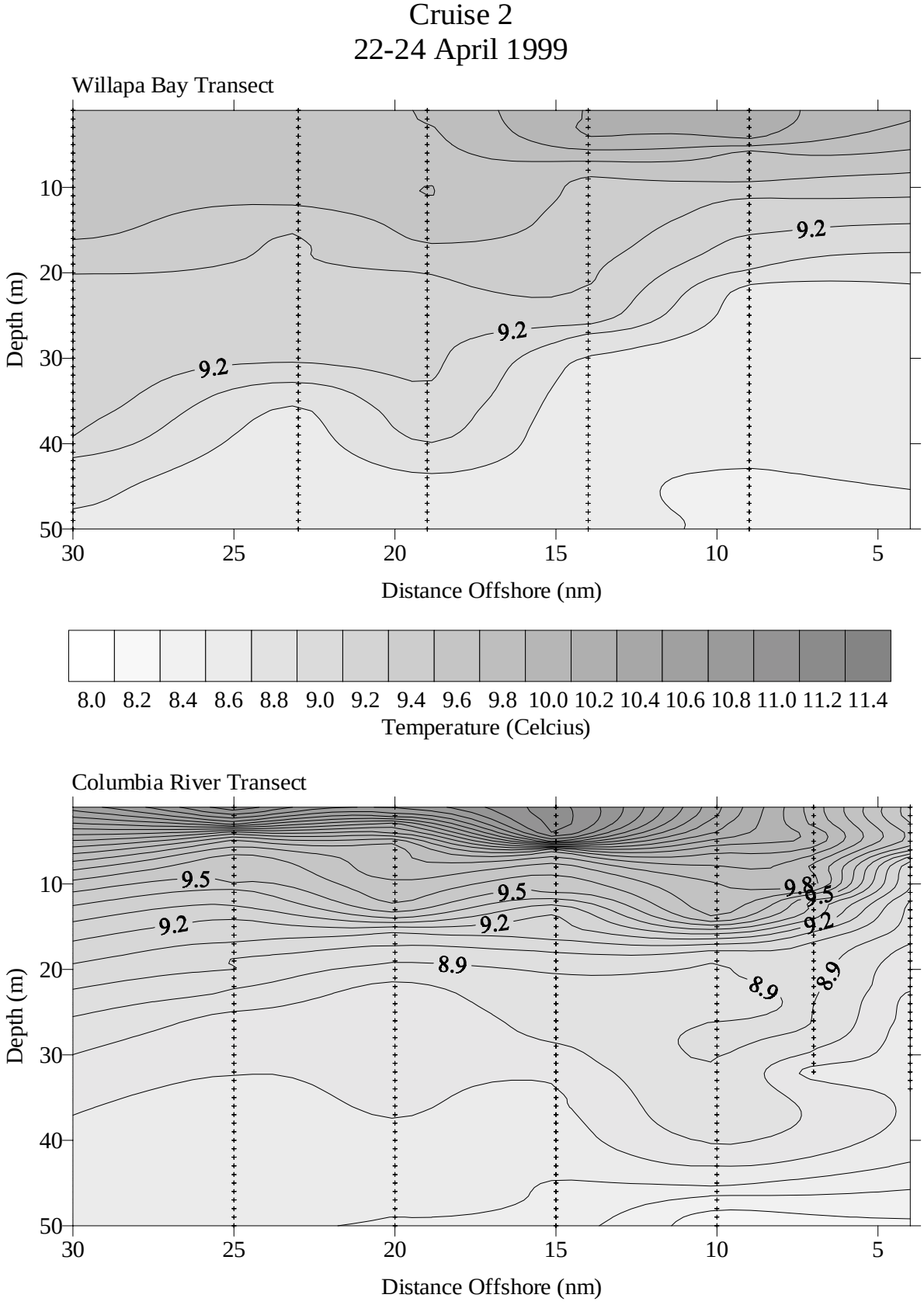
APPENDIX 2:

TEMPERATURE AND SALINITY PROFILES

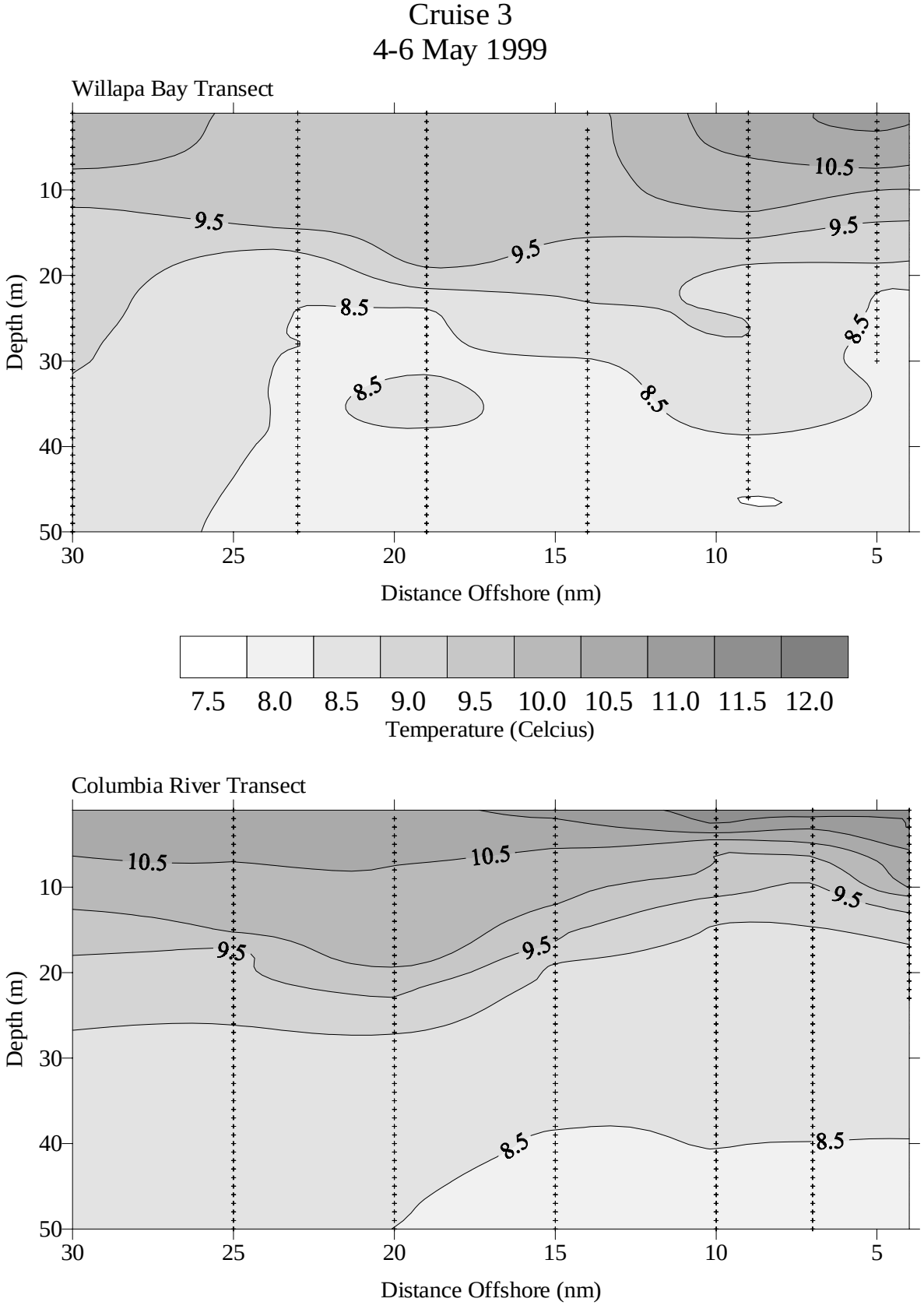
Appendix 2. Temperature and salinity profiles along transects north (Willapa Bay) and south (Columbia River) off the Columbia River while surface trawling1999.



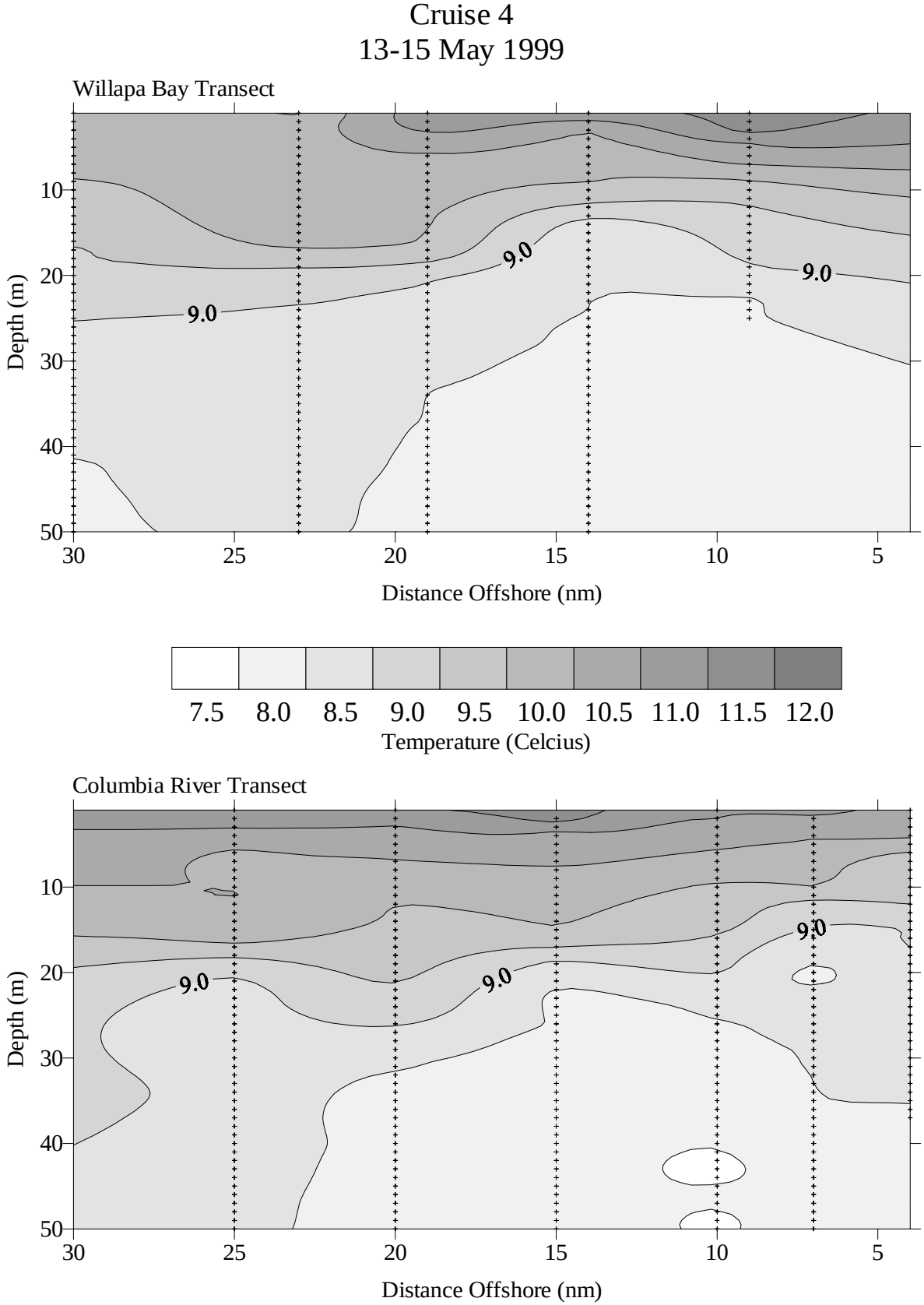
Appendix 2. Continued.



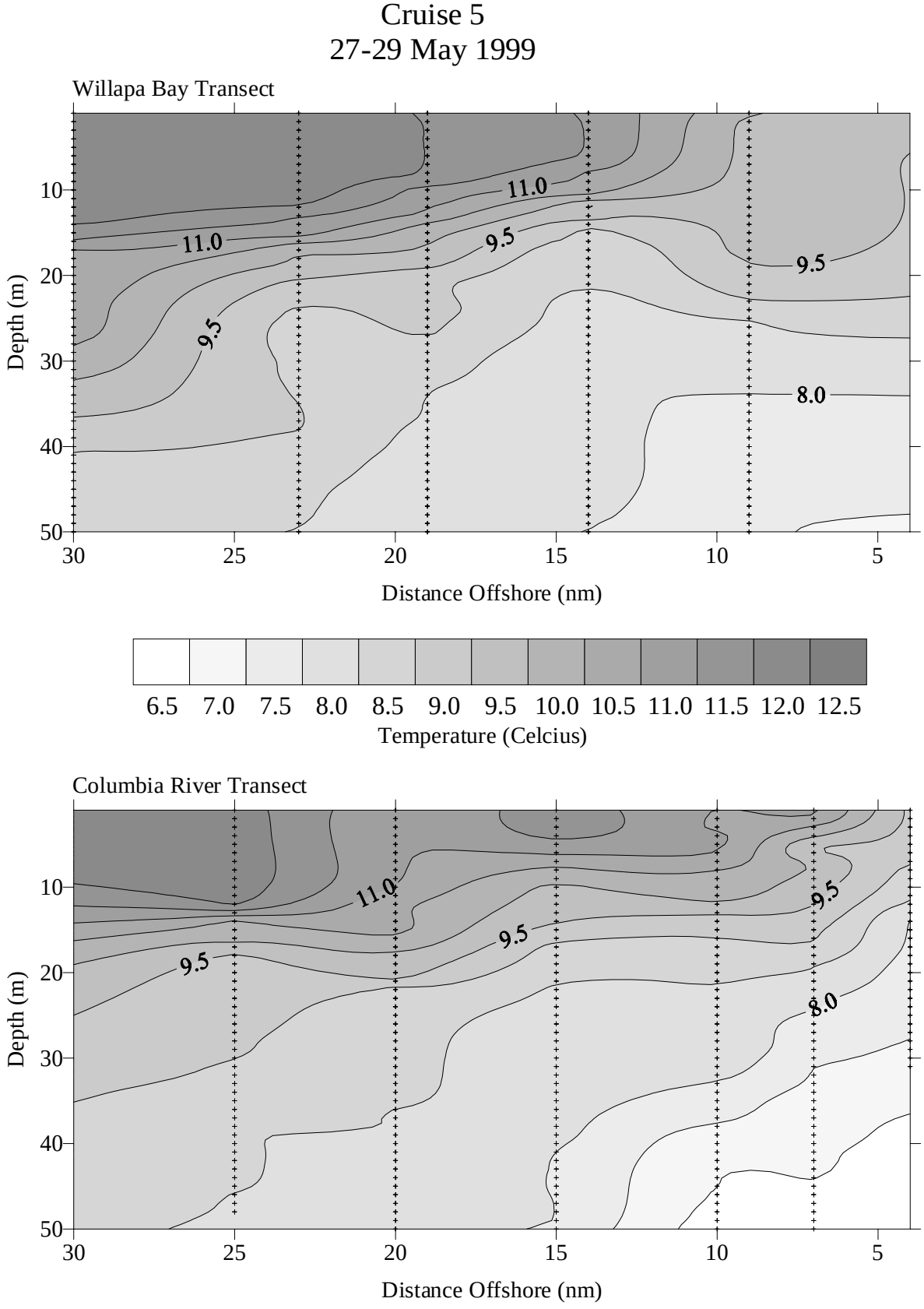
Appendix 2. Continued.



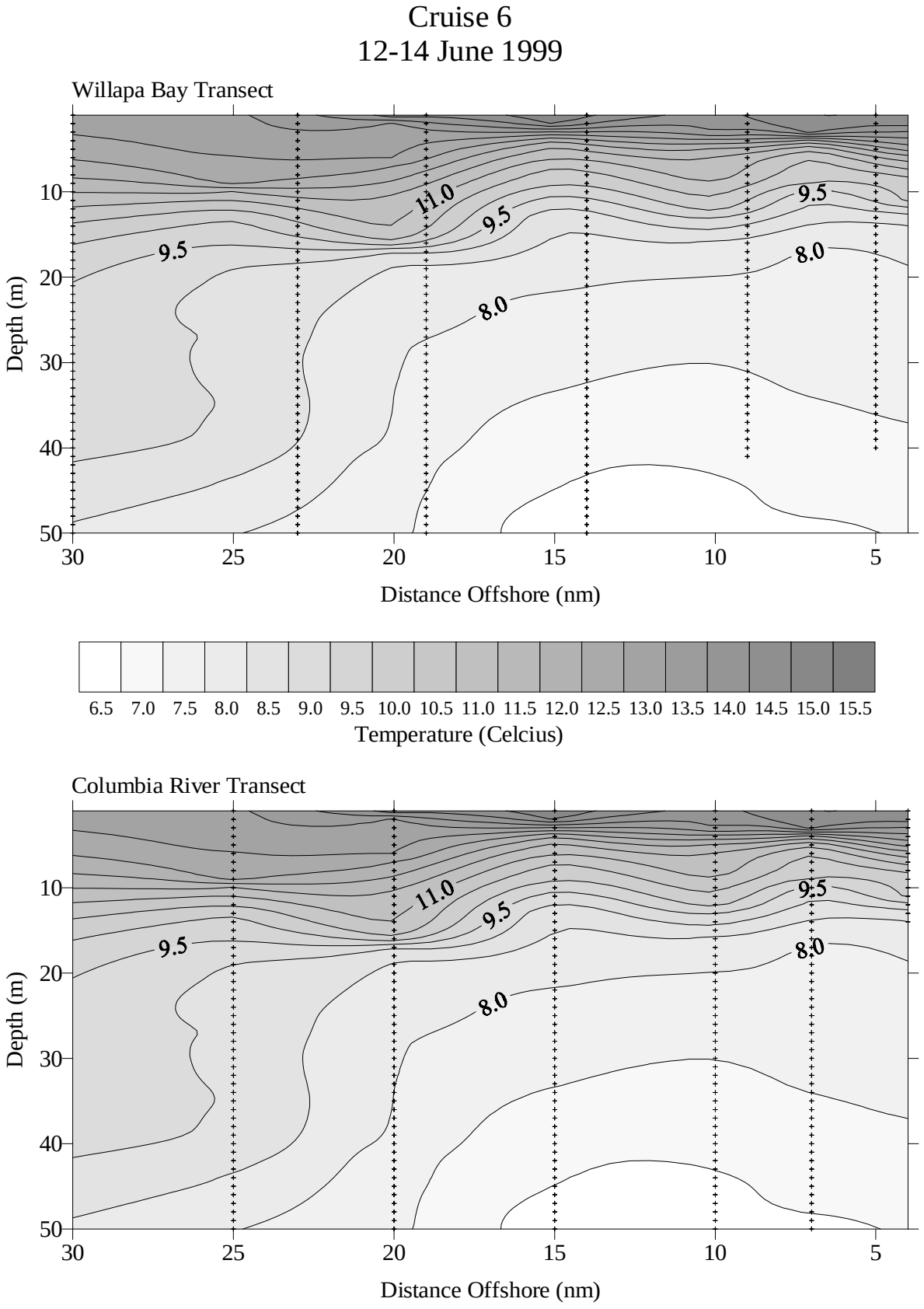
Appendix 2. Continued.



Appendix 2. Continued.

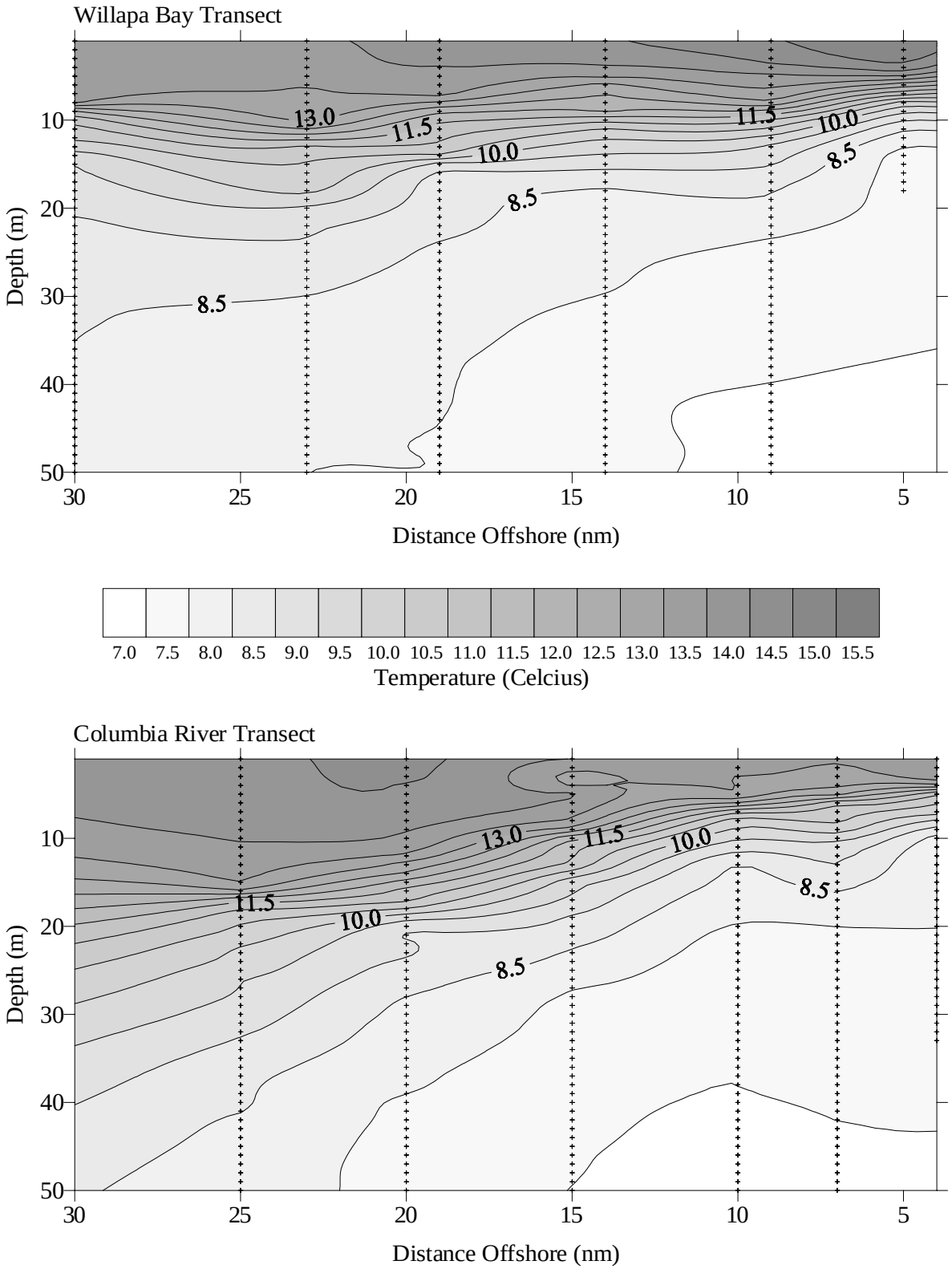


Appendix 2. Continued.



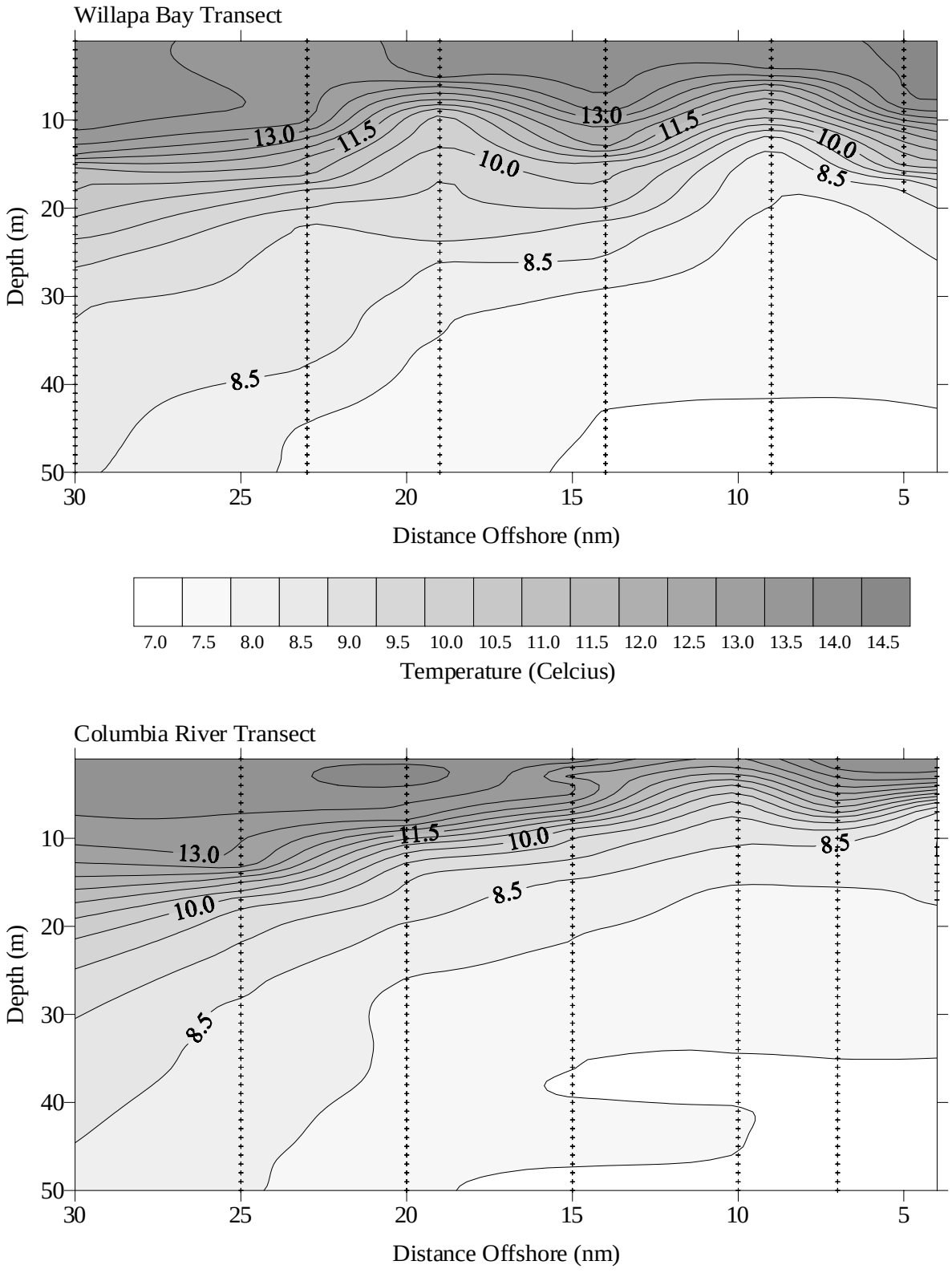
Appendix 2. Continued.

Cruise 7
25-27 June 1999

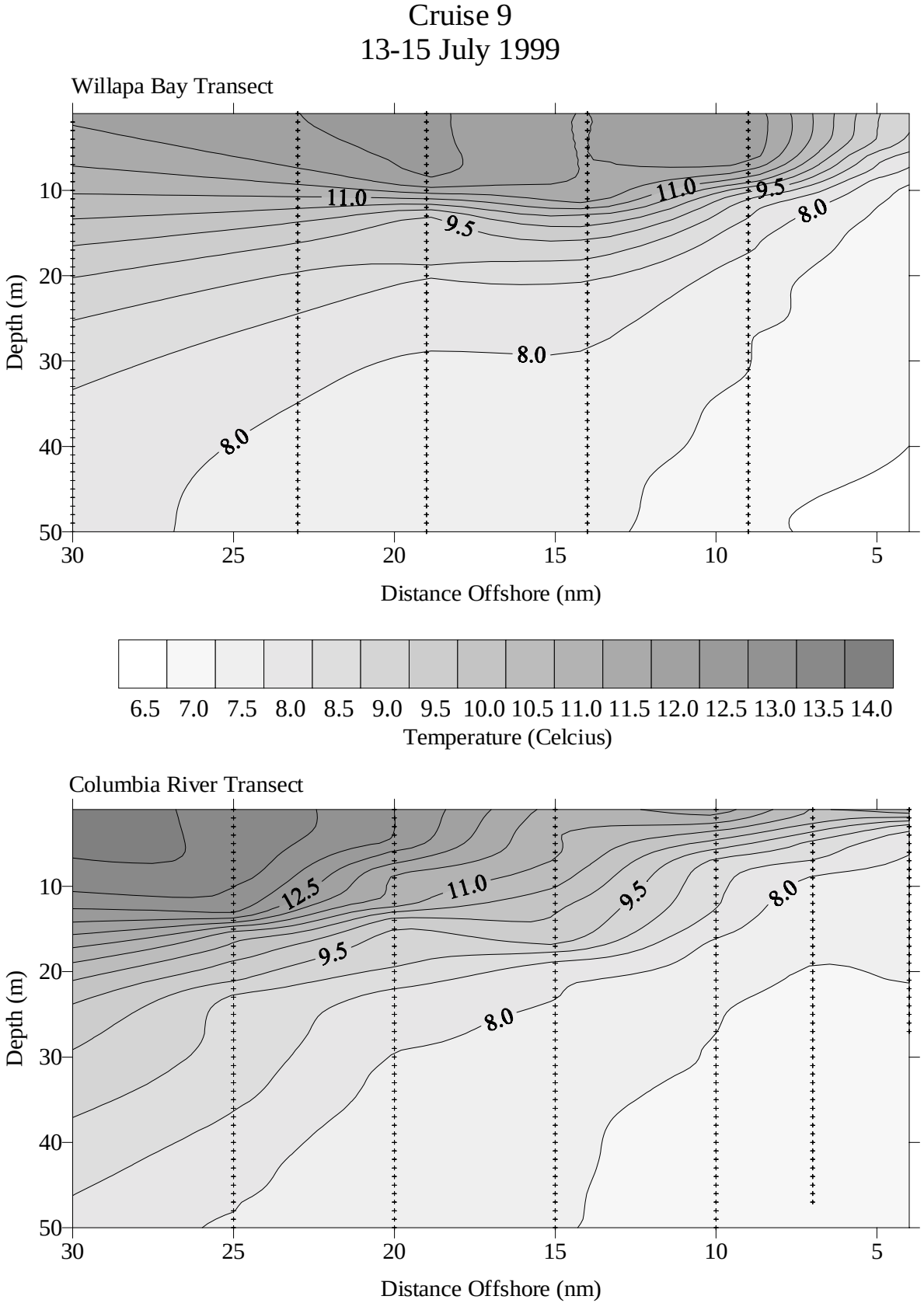


Appendix 2. Continued.

Cruise 8
6-8 July 1999



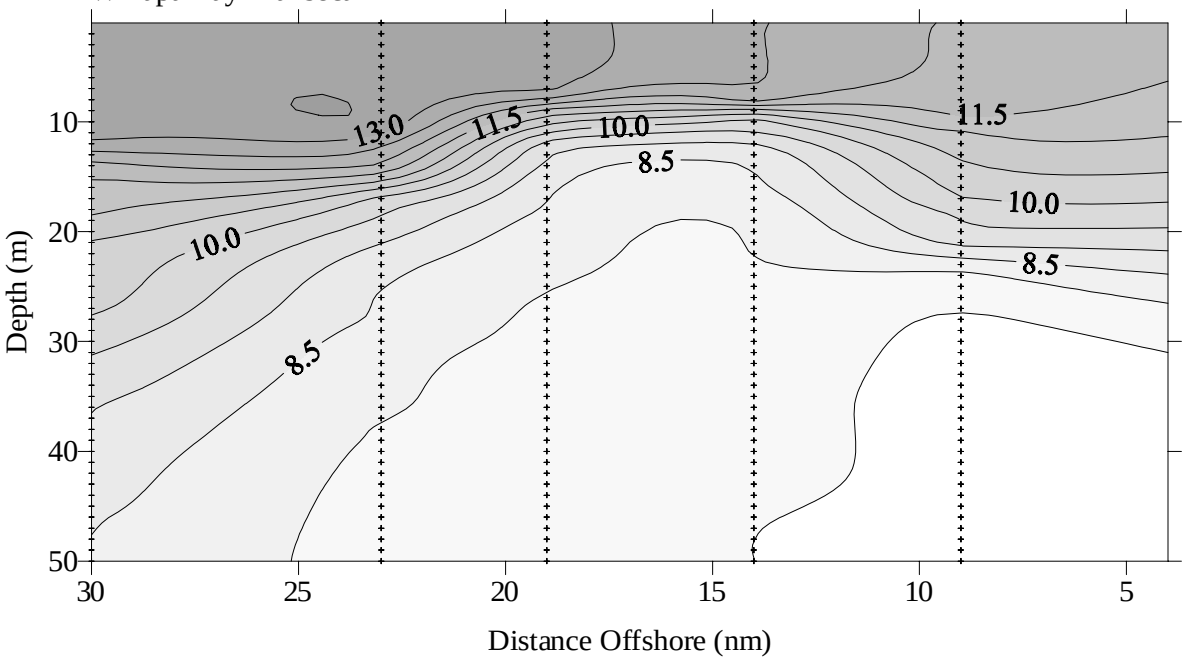
Appendix 2. Continued.



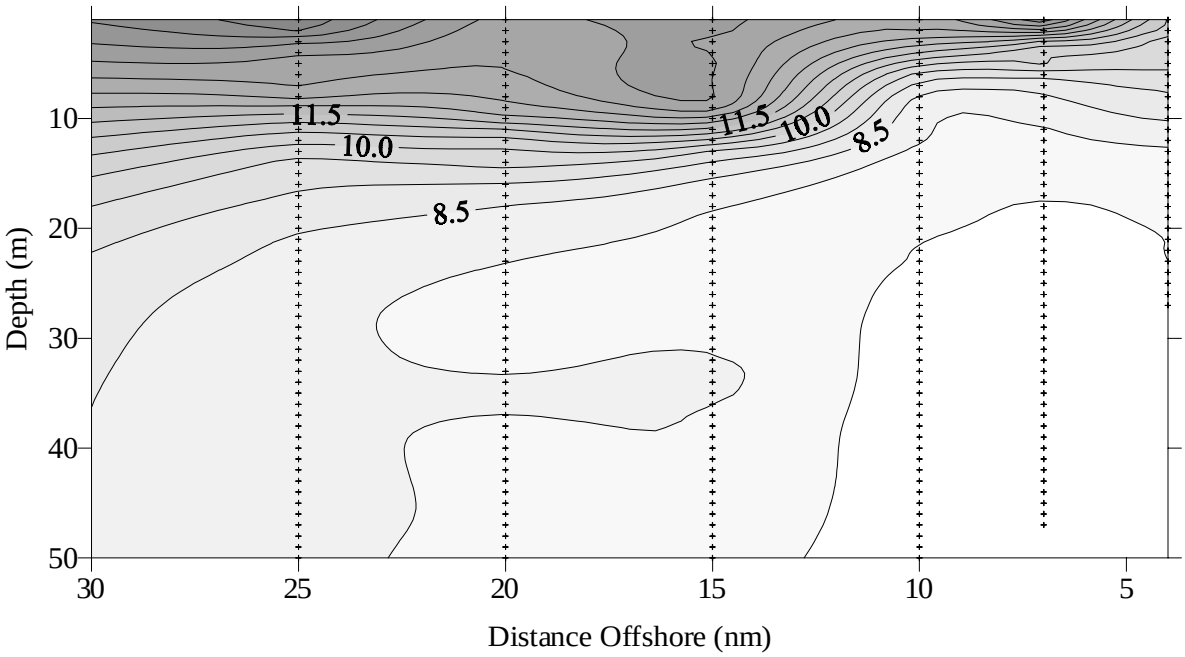
Appendix 2. Continued.

Cruise 10
27-29 July 1999

Willapa Bay Transect

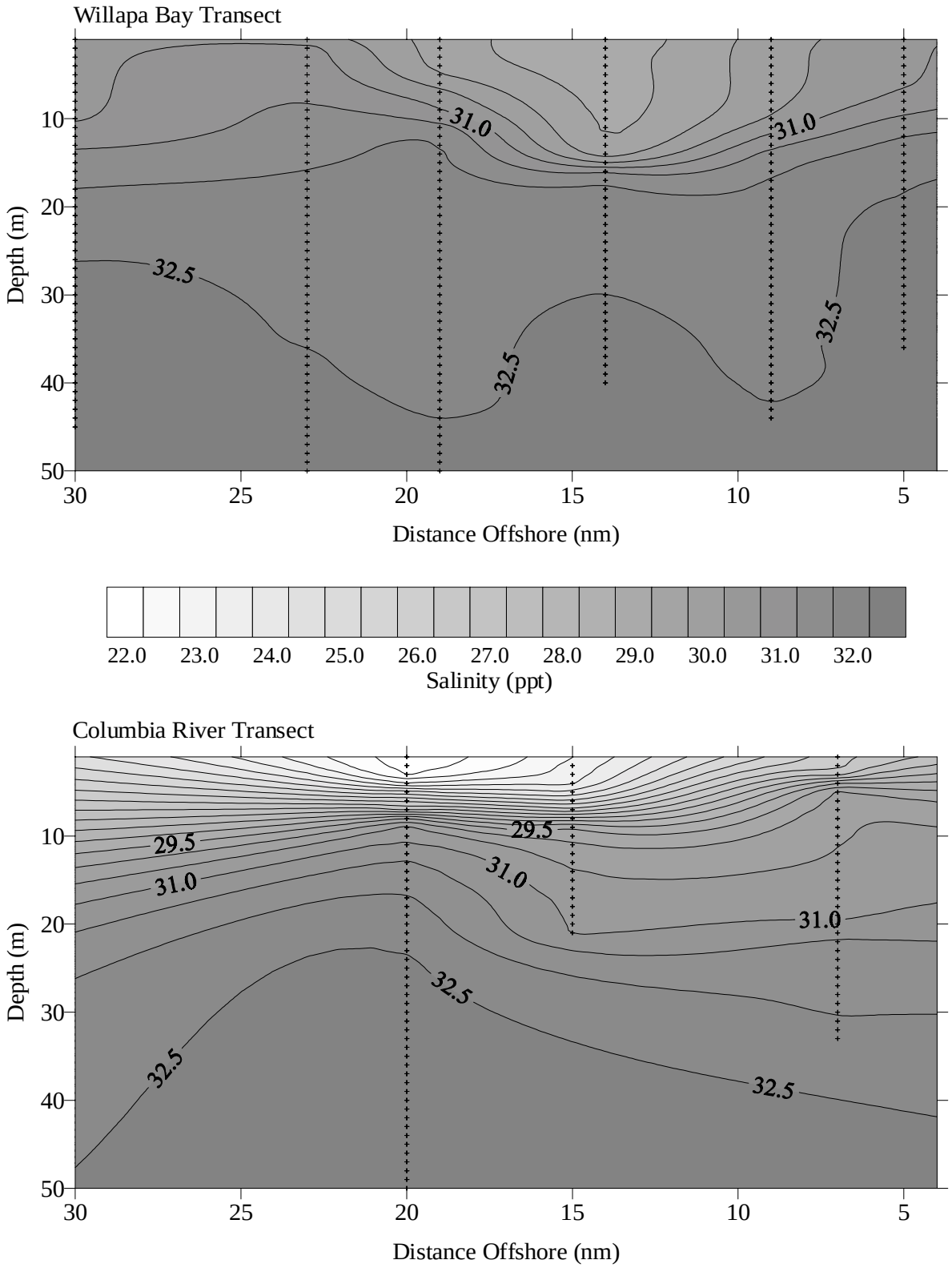


Columbia River Transect

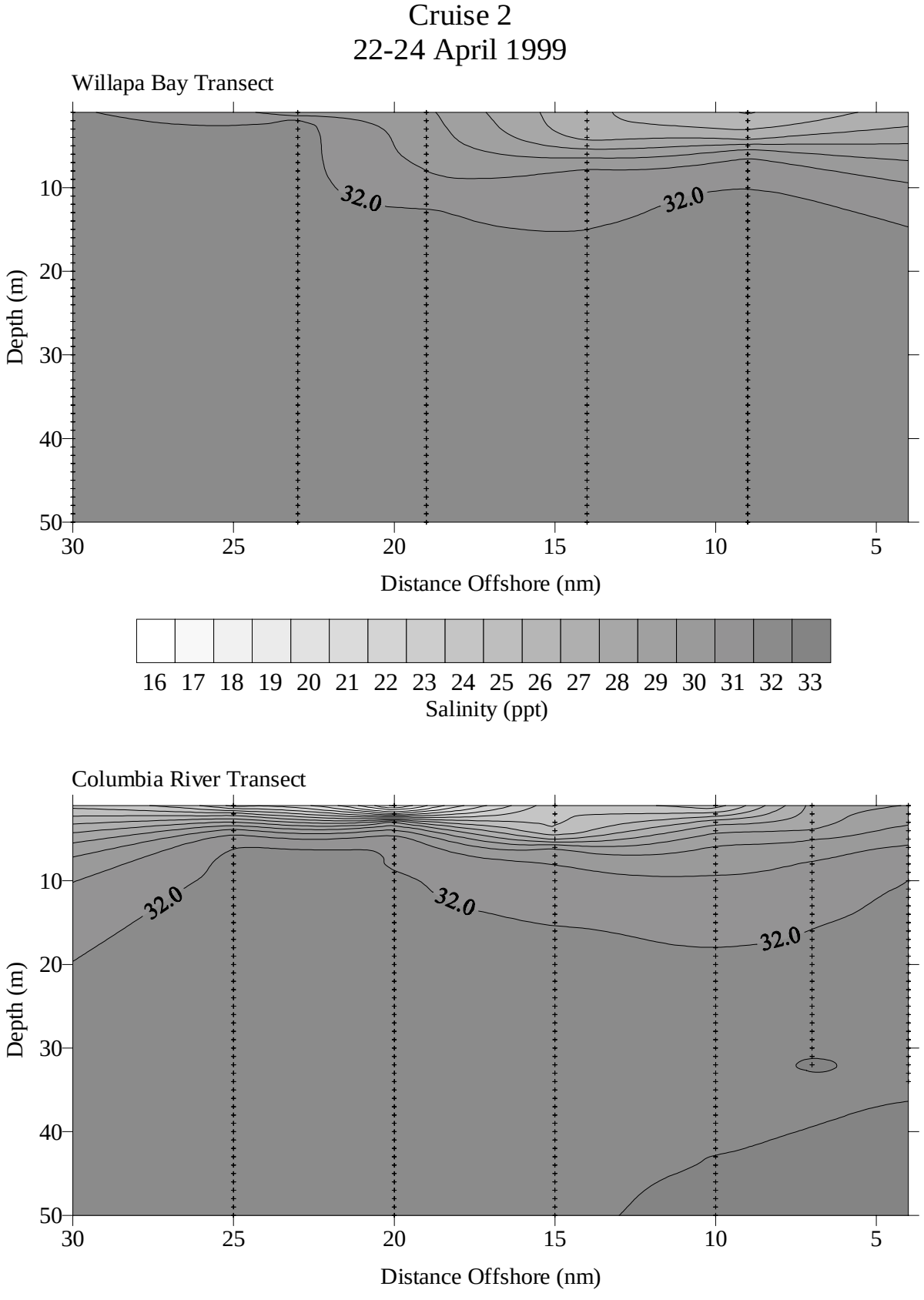


Appendix 2. Continued.

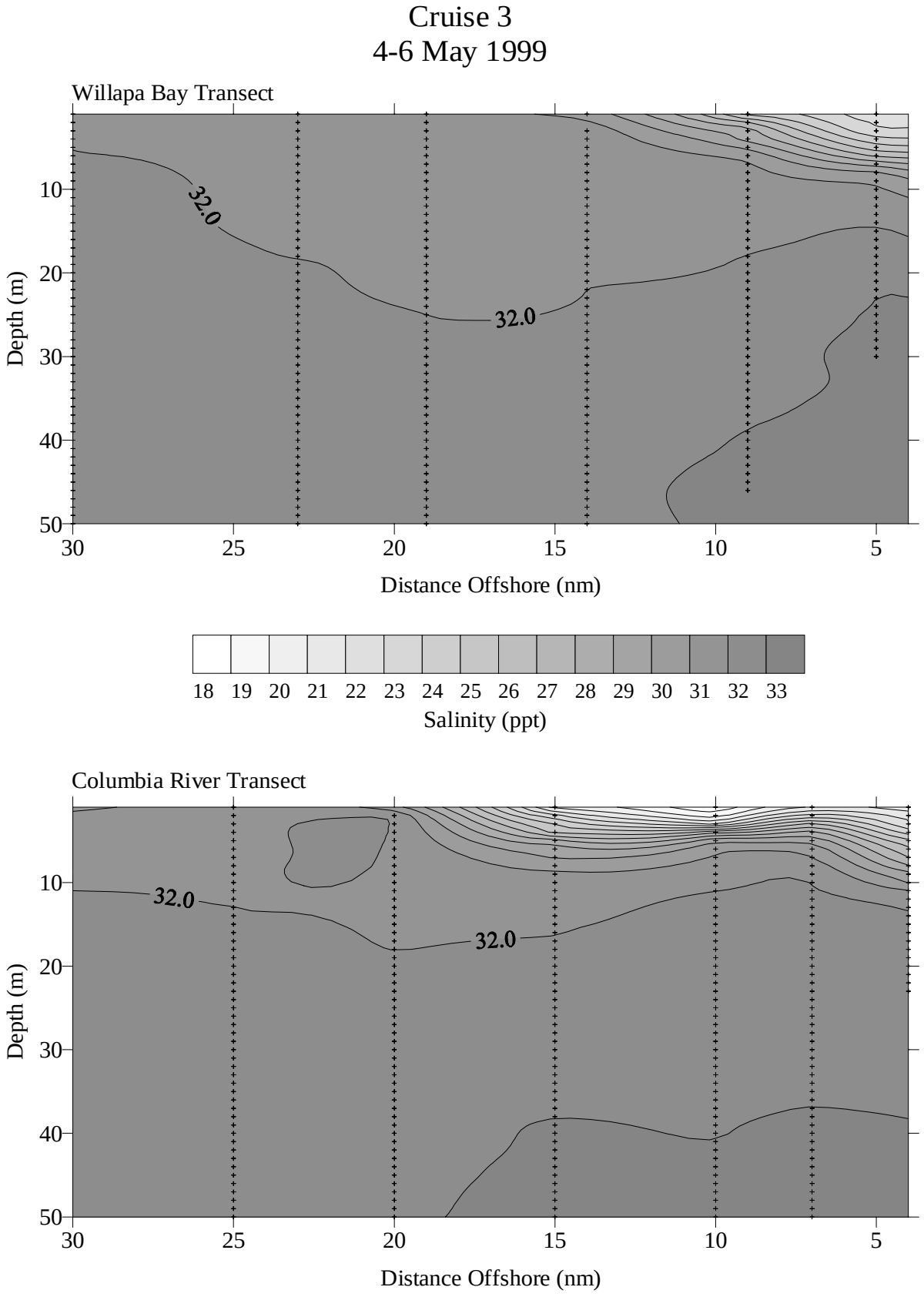
Cruise 1
13-15 April 1999



Appendix 2. Continued.

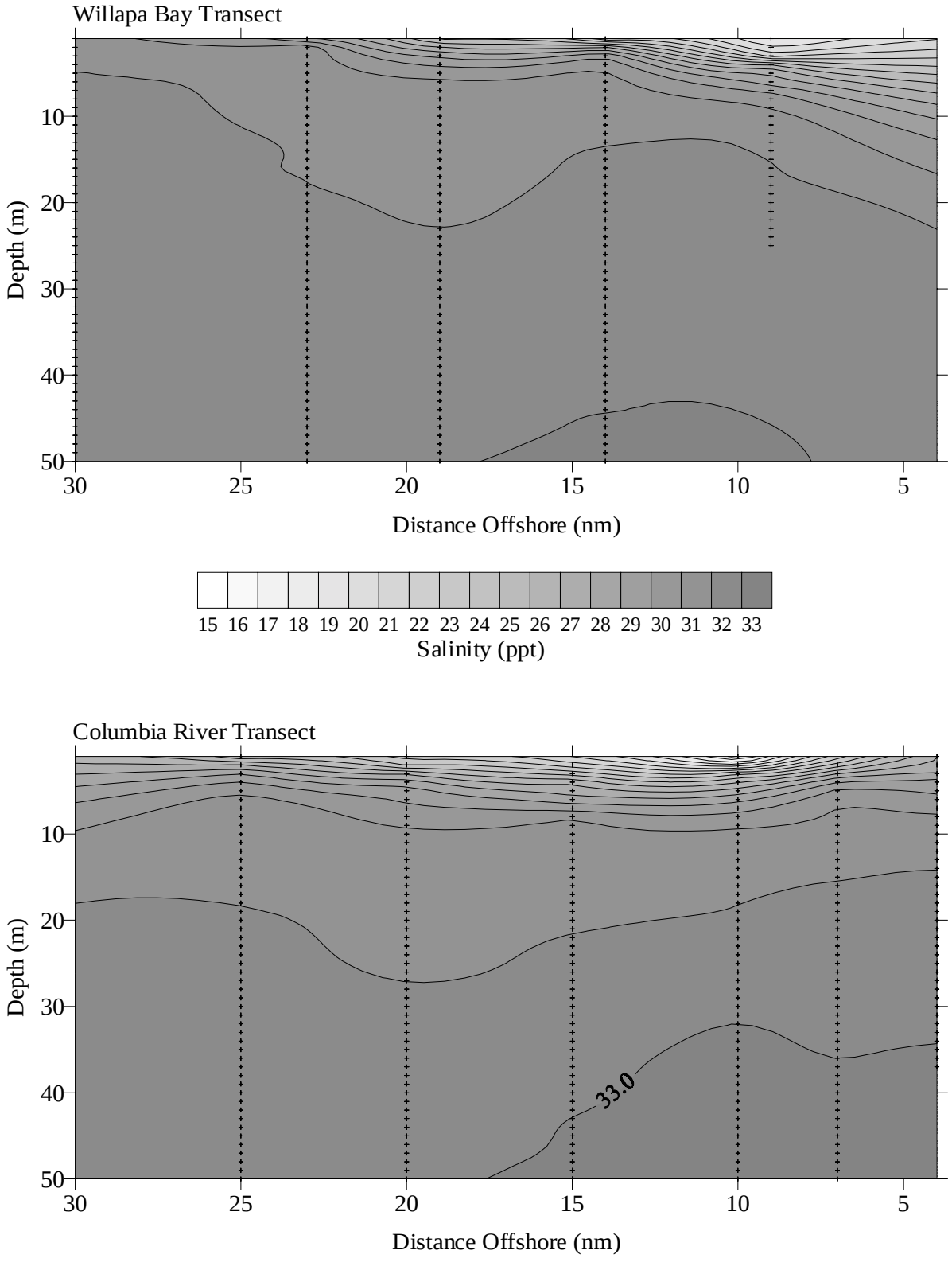


Appendix 2. Continued.



Appendix 2. Continued.

Cruise 4
13-15 May 1999



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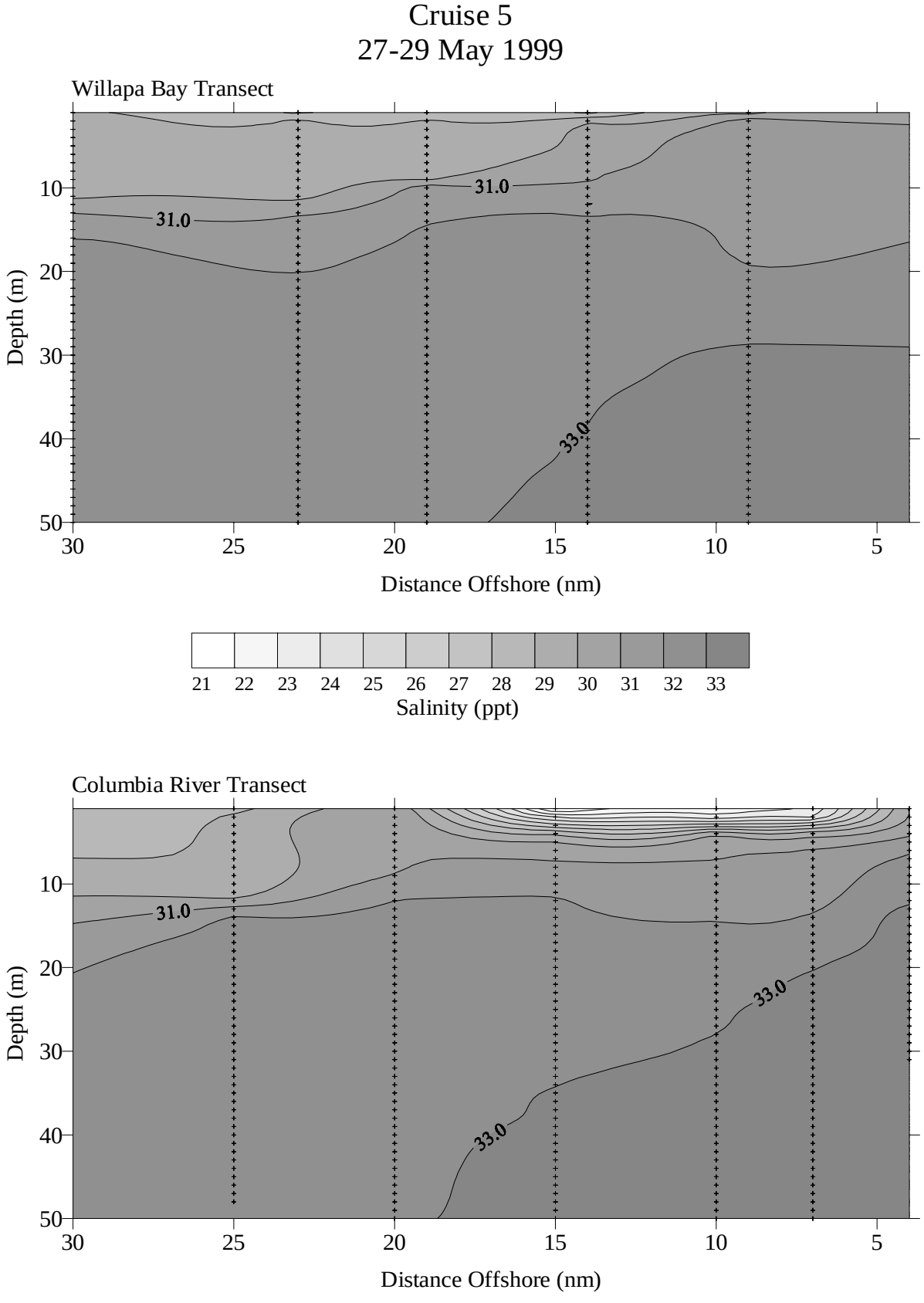

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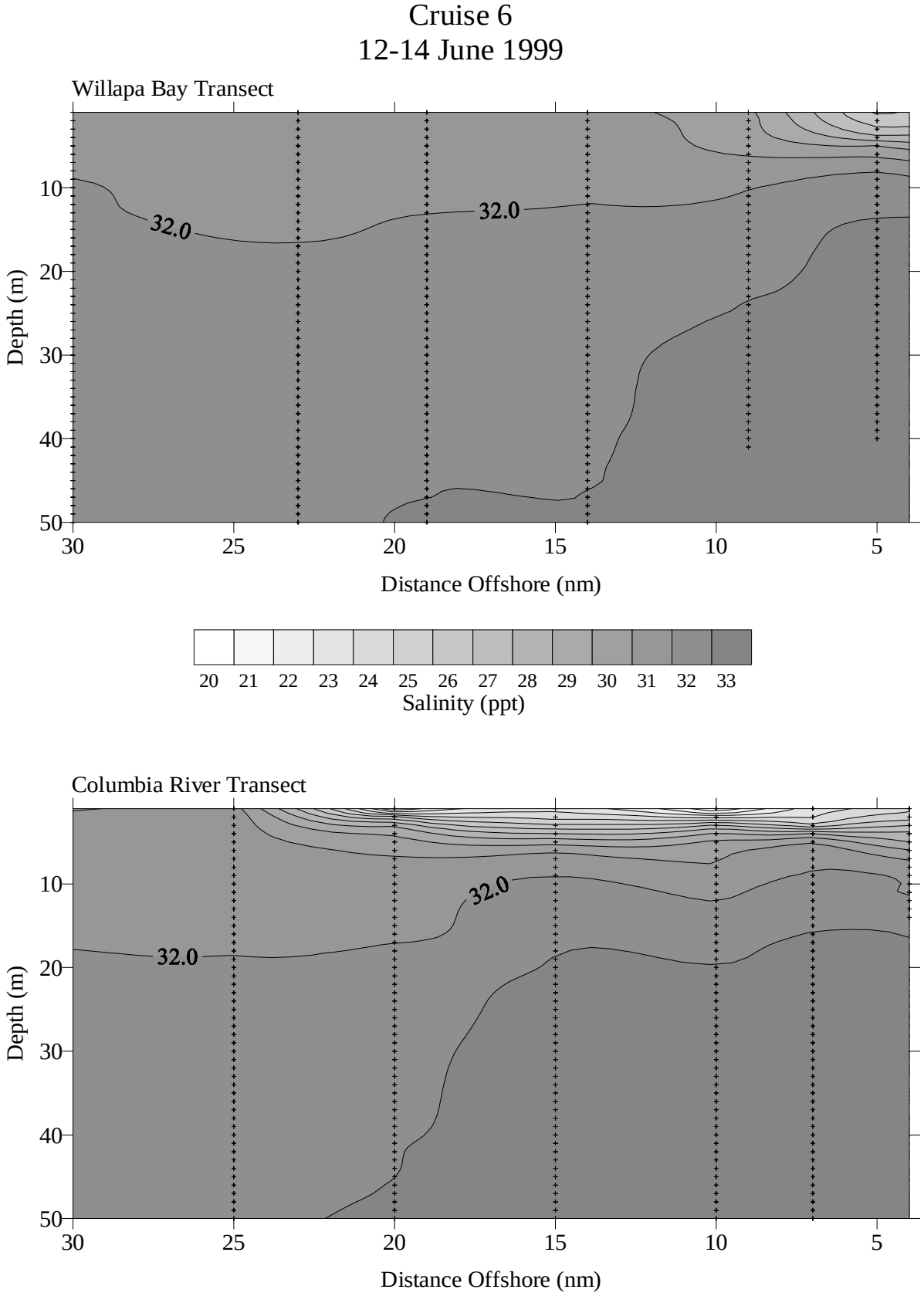

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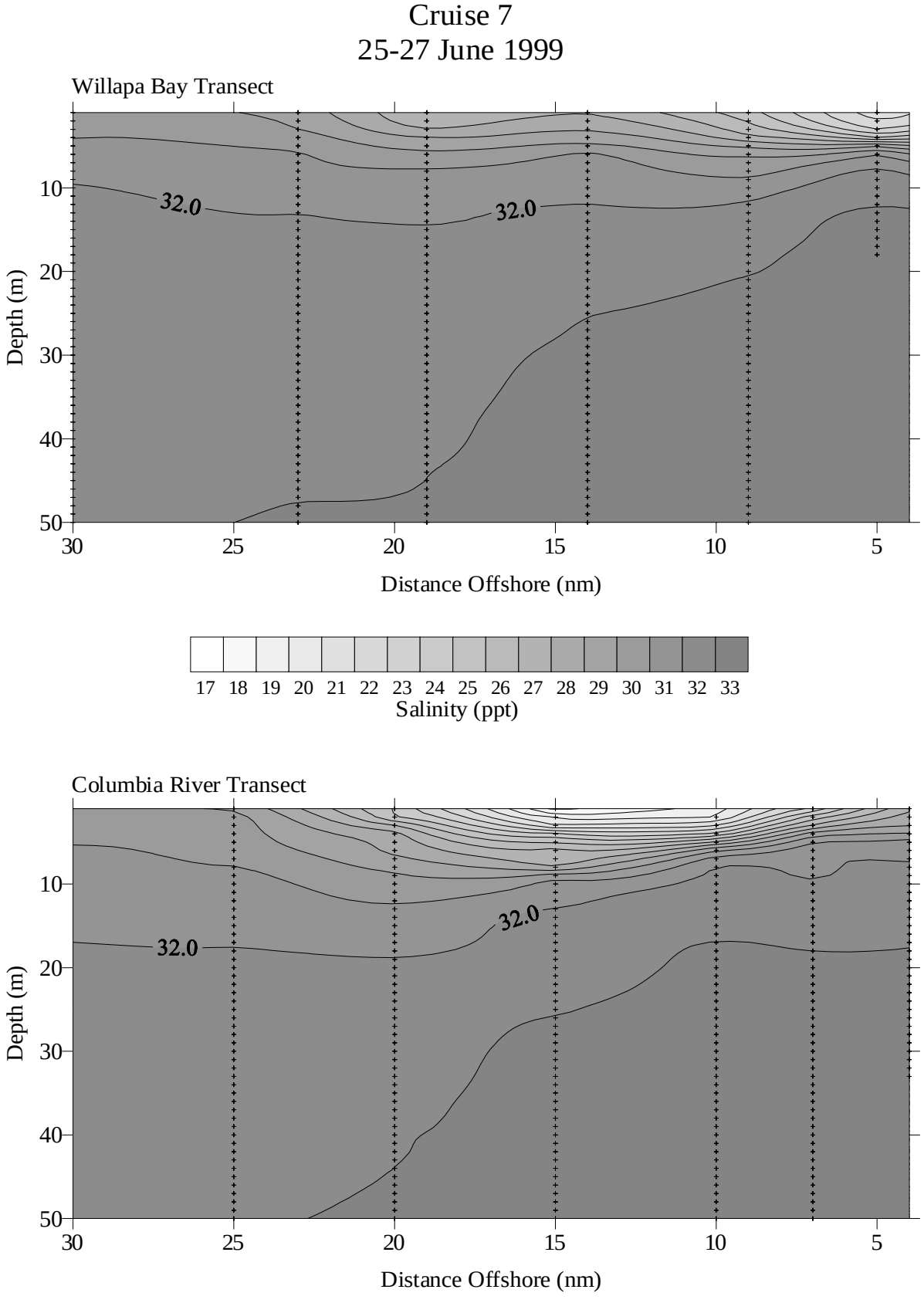
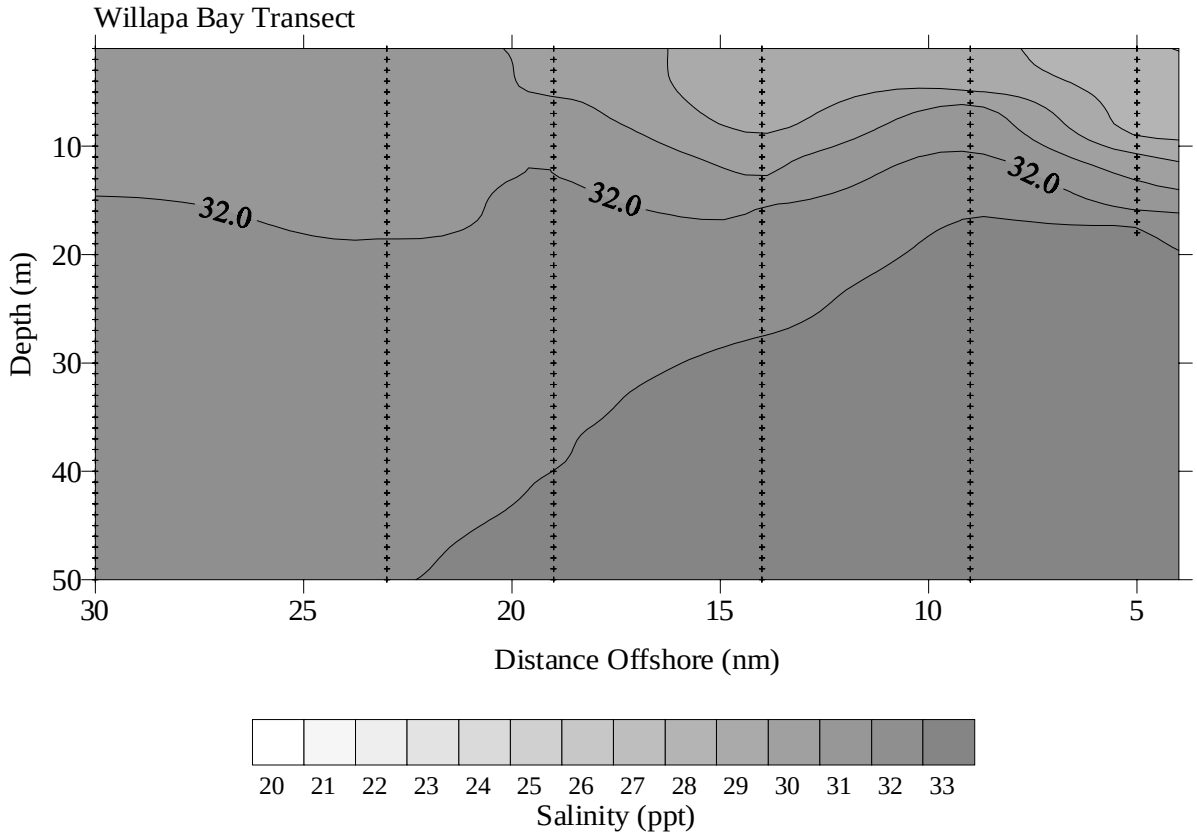
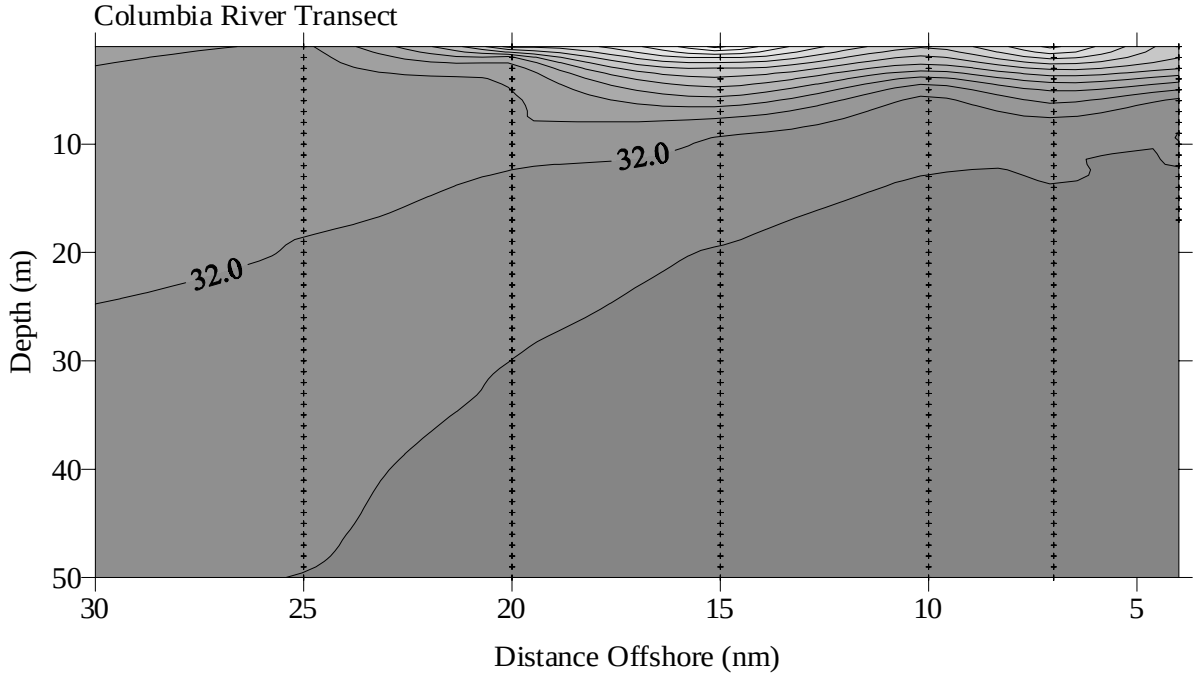


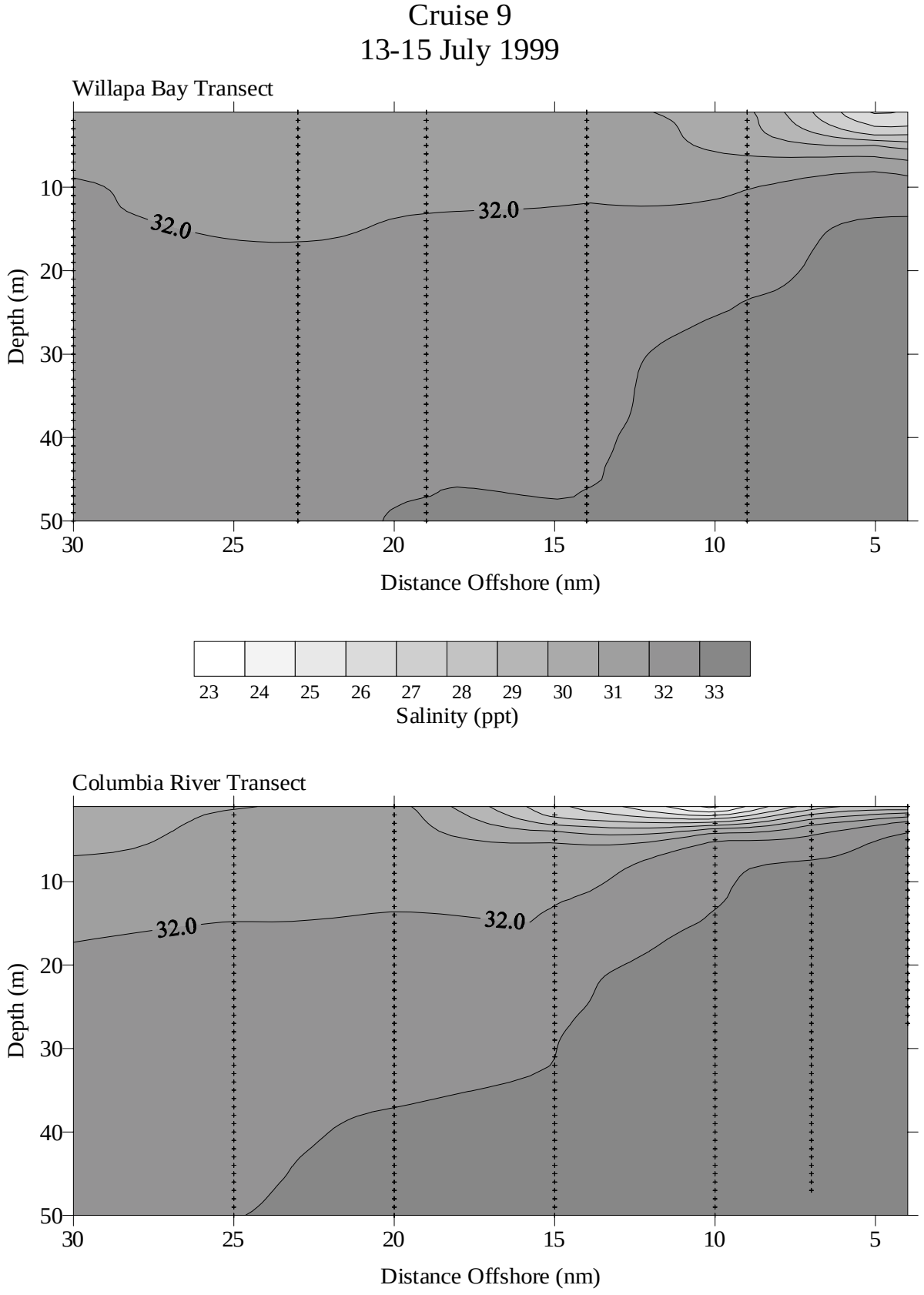
Appendix 2. Continued.

Cruise 8
6-8 July 1999





Appendix 2. Continued.



Appendix 2. Continued.